

AD-A067 296

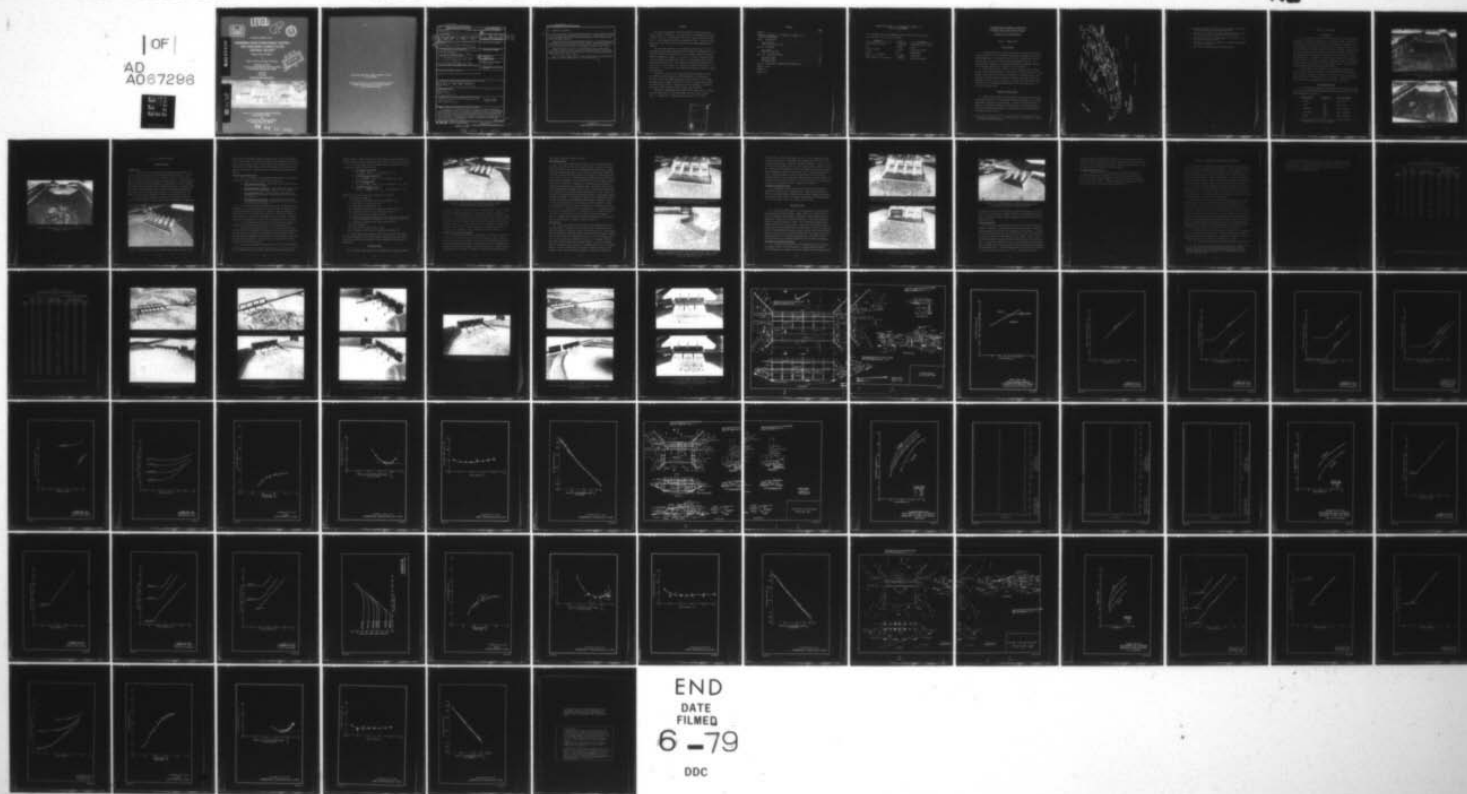
ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MISS F/G 13/2
KISSIMMEE RIVER STRUCTURES, CENTRAL AND SOUTHERN FLORIDA FLOOD --ETC(U)
MAR 79 H O TURNER, G A PICKERING

UNCLASSIFIED

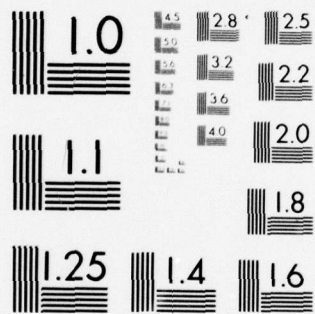
WES-TR-HL-79-4

NL

1 OF 1
AD
A067296



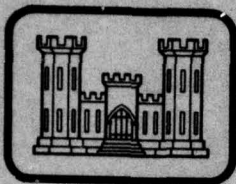
END
DATE
FILMED
6-79
DDC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

LEVEL

12
B.S.



TECHNICAL REPORT HL-79-4

KISSIMMEE RIVER STRUCTURES, CENTRAL AND SOUTHERN FLORIDA FLOOD CONTROL PROJECT

Hydraulic Model Investigation

by

Herman O. Turner, Jr., Glenn A. Pickering

Hydraulics Laboratory

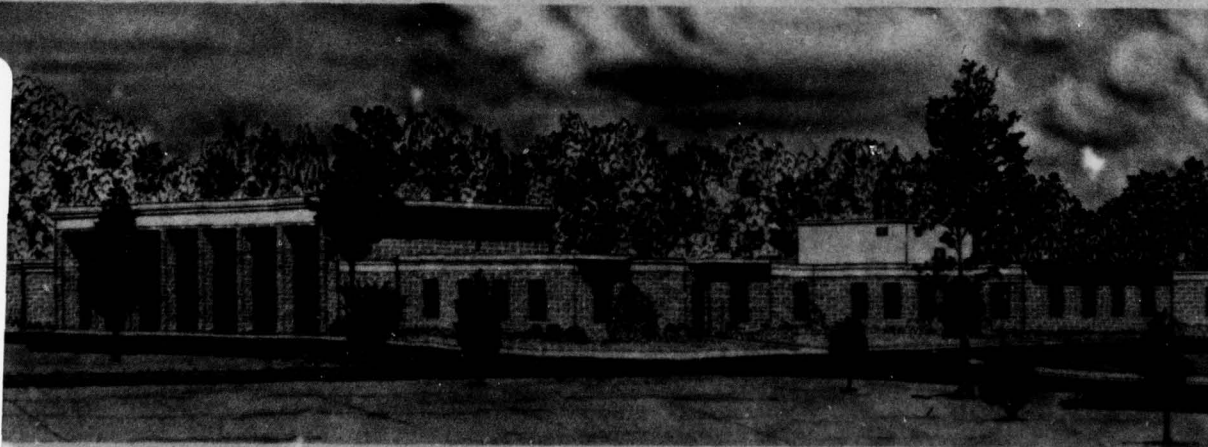
U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Miss. 39180

March 1979

Final Report

Approved For Public Release; Distribution Unlimited

DDC
RECEIVED
APR 16 1979
C



Prepared for U. S. Army Engineer District, Jacksonville
Jacksonville, Fla. 32201

and

South Florida Water Management District
West Palm Beach, Fla. 33402

79 04 13 002

AD A0 67296

DDC FILE COPY

Destroy this report when no longer needed. Do not return
it to the originator.

The findings in this report are not to be construed as an official
Department of the Army position unless so designated
by other authorized documents.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Technical Report HL-79-4	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER ⑨
4. TITLE (and Subtitle) ⑥ KISSIMMEE RIVER STRUCTURES, CENTRAL AND SOUTHERN FLORIDA FLOOD CONTROL PROJECT, Hydraulic Model Investigation	5. TYPE OF REPORT & PERIOD COVERED Final report - Nov 75 - Jul 77	
7. AUTHOR(s) ⑩ Herman O. Turner, Jr. / Glenn A. Pickering	6. PERFORMING ORG. REPORT NUMBER	
9. PERFORMING ORGANIZATION NAME AND ADDRESS U. S. Army Engineer Waterways Experiment Station Hydraulics Laboratory P. O. Box 631, Vicksburg, Miss. 39180	8. CONTRACT OR GRANT NUMBER(s)	
11. CONTROLLING OFFICE NAME AND ADDRESS U. S. Army Engineer District, Jacksonville P. O. Box 4970, Jacksonville, Fla. 33201 and South Florida Water Management District P. O. Box V, West Palm Beach, Fla. 33402	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	12. REPORT DATE ⑪ March 1979	
	13. NUMBER OF PAGES 66	
	15. SECURITY CLASS. (of this report) Unclassified	
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) ⑭ WES-TR-HL-79-4		
18. SUPPLEMENTARY NOTES ⑬ 74 p.		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Central and Southern Florida Flood Control Project Hydraulic models Control structures Kissimmee River Flood control -- Florida		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Kissimmee River structures S-65E, S-65D, and S-65B were reproduced in a 1:20-scale model in order to study ways of eliminating scour of the downstream riprap blankets by means of structural modifications of operating procedures. All of the models had low ogee type spillways with vertical lift gates. The models and testing conditions were reproduced according to prototype data received from the U. S. Army Engineer District, Jacksonville, and the South Florida Water Management District. (Continued)		

DD FORM 1 JAN 73 1473

EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

038 200

79 04 13 002

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

20. ABSTRACT (Continued).

Cont → The only structure that has baffle blocks in the stilling basin is S-65E, and it has experienced a negligible amount of scour. Results show that little or no scour damage should have occurred downstream from the structure under normal operating conditions.

Structures S-65D and S-65B experienced heavy scour of the downstream riprap blankets during a high discharge period in 1969. Two methods were evaluated to reduce the scouring action: placing baffle blocks in the stilling basin and replacing the existing 18-inch riprap with larger sizes of stone.

Economic analysis by the U. S. Army Engineer District, Jacksonville, showed that it would be more economical to add baffle blocks to the stilling basins than increase the size of the riprap. Thus, only structure S-65D was tested with larger sizes of riprap.

The test results showed that the scour potential will be greatly reduced by adding two rows of baffle blocks to the stilling basins. ↑

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

PREFACE

The model investigation reported herein was authorized by the Office, Chief of Engineers, U. S. Army (OCE), on 24 March 1975 at the request of the U. S. Army Engineer Division, South Atlantic (SAD) and the U. S. Army Engineer District, Jacksonville (SAJ). Sponsors of the model study were SAJ and the South Florida Water Management District (SFWMD).

The study was conducted in the Hydraulics Laboratory of the U. S. Army Engineer Waterways Experiment Station (WES) from November 1975 to July 1977 under the direction of Mr. H. B. Simmons, Chief of the Hydraulics Laboratory, and Mr. J. L. Grace, Jr., Chief, Structures Division, and under the supervision of Mr. G. A. Pickering, Chief, Locks and Conduits Branch (LCB). The engineer in immediate charge of the model was Mr. H. O. Turner, Jr., LCB, who was assisted by Messrs. J. V. Hines and J. H. Riley, LCB. This report was prepared by Messrs. Turner and Pickering.

During the course of the investigation, SAJ personnel, Messrs. Bob Bullock, Henry Anderson, and Charles McManus; SAD personnel, Mr. Bert Holler; and SFWMD personnel, Messrs. Richard Irons, Joseph Schweigart, and Richard Slyfield, visited WES to observe model operation and discuss results. Observations of the prototype structures were made by WES personnel, Messrs. Turner and Pickering.

Directors of WES during the conduct of the tests and the preparation and publication of this report were COL G. H. Hilt, CE, and COL J. L. Cannon, CE. Technical Director was Mr. F. R. Brown.

ACCESSION for	
NTIS	White Section <input checked="" type="checkbox"/>
DDC	Buff Section <input type="checkbox"/>
UNANNOUNCED	<input type="checkbox"/>
JUSTIFICATION	
BY	
DISTRIBUTION/AVAILABILITY CODES	
Dist	SPECIAL
A	

CONTENTS

	<u>Page</u>
PREFACE	1
CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI)	
UNITS OF MEASUREMENT	3
PART I: INTRODUCTION	4
The Prototype	4
Purpose and Model Study	4
PART II: THE MODEL	7
Description	7
Scale Relationships	7
PART III: TESTS AND RESULTS	10
Structure S-65E	10
Structure S-65D	12
Structure S-65B	16
PART IV: DISCUSSION OF RESULTS AND CONCLUSIONS	20
TABLES 1 and 2	
PHOTOS 1-7	
PLATES 1-37	

CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI)
UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
cubic feet per second	0.02831685	cubic metres per second
feet	0.3048	metres
feet per second	0.3048	metres per second
inches	25.4	millimetres
miles (U. S. statute)	1.609344	kilometres
square miles (U. S. statute)	2.589988	square kilometres

KISSIMMEE RIVER STRUCTURES, CENTRAL AND
SOUTHERN FLORIDA FLOOD CONTROL PROJECT

Hydraulic Model Investigation

PART I: INTRODUCTION

The Prototype

1. The Kissimmee River control structures are located in Central Florida (Figure 1) in the floodplain and general alignment of the existing Kissimmee River. They were built by the U. S. Army Corps of Engineers as part of a flood control channel improvement project. The structures are operated by the South Florida Water Management District, a state agency authorized to represent local interests.

2. The overall project consists of six structures (S-65 through S-65E) and six navigation locks. Each lock is 30 ft* wide by 90 ft long and has sector gates to provide for navigation of pleasure craft. The spillways consist of gated, reinforced concrete structures with crests designed to conform to an ogee shape. The gates are vertical-lift type. The width of the structures ranges from 87.5 ft (three-gate bays) to 179.5 ft (six-gate bays).

Purpose of Model Study

3. During October 1969, a heavy rainfall associated with tropical storm Jenny resulted in a flood which caused scour damage to the riprap downstream from some of the structures. A model study was needed to study the problem and evaluate the effectiveness of structural modifications and operating procedures. Specifically, it was expected that the model would be used to:

* A table for converting U. S. customary units of measurement to metric (SI) units is given on page 3.

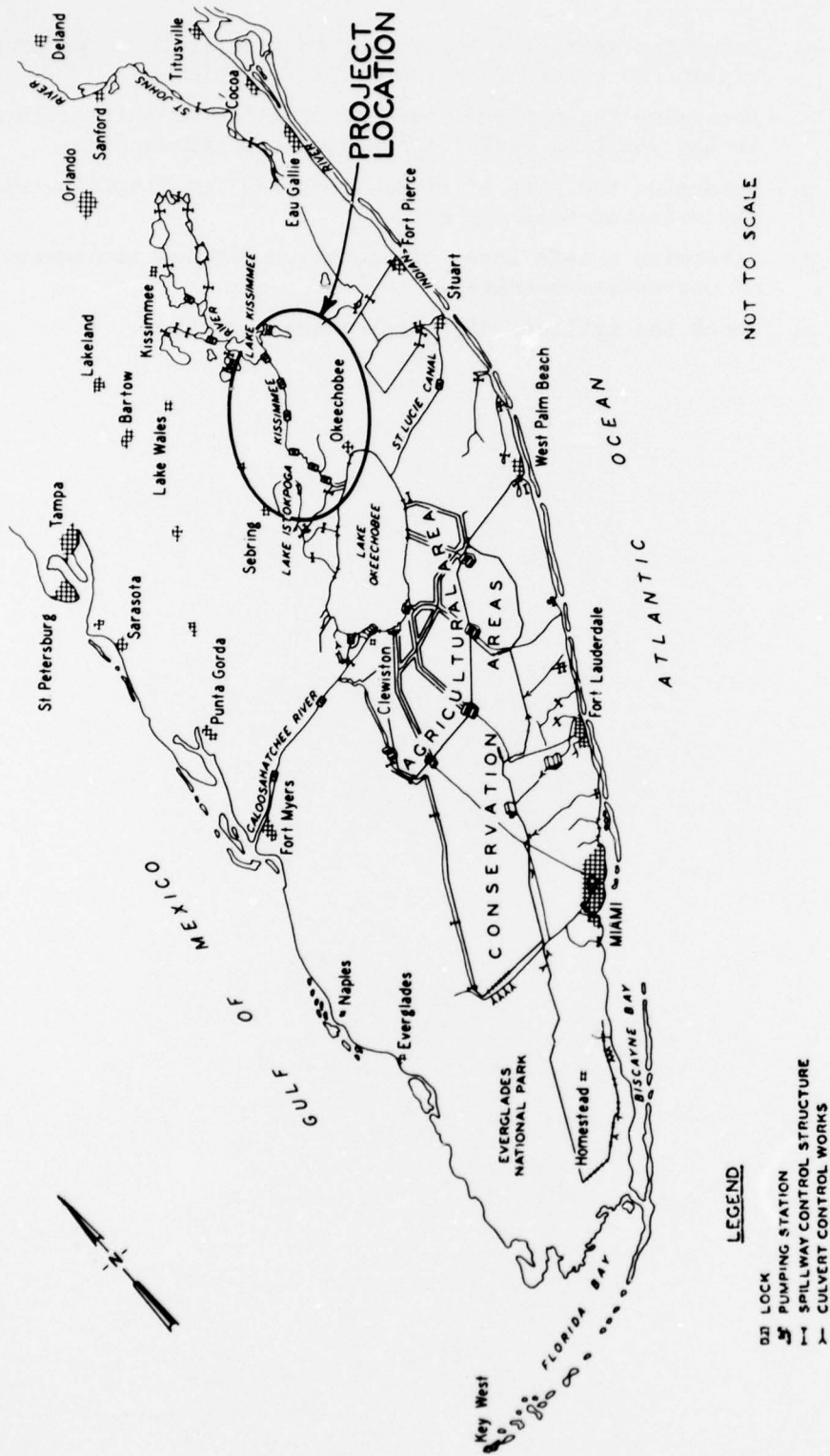


Figure 1. Location map

- a. Determine hydraulic conditions that initiate scour of the riprap downstream from the stilling basins.
- b. Determine the optimum size and location of baffle blocks in the stilling basins to reduce scour tendencies.
- c. Determine the size of riprap required for stability with the existing stilling basins.
- d. Determine a safe level of operation pending implementation of corrective measures.
- e. Check the spillway discharge characteristics.

PART II: THE MODEL

Description

4. The 1:20-scale model was built according to prototype as-built drawings. The model included 250 ft of approach channel, the control structures, and 800 ft of exit channel. The model was initially constructed with the six-bay structure (S-65E) as shown in Figure 2, and later modified to simulate one of the four-bay structures, S-65D, (Figure 3), and then one of the three-bay structures, S-65B, (Figure 4). The approach and exit channels were molded in cement mortar to sheet metal templates. A mixture of crushed stone was placed in the appropriate areas to accurately simulate the prototype riprap. The spillway structures were constructed of plastic-coated plywood. The spillway and gate piers were fabricated of sheet metal.

5. Water used in the operation of the model was supplied by a constant head tank and discharges were measured with venturi meters. Water-surface elevations were measured with point gages and piezometers. Water velocities were measured with a pitot tube. Tailwater elevations were regulated by an adjustable gate at the end of the flume.

Scale Relationships

6. The equations of hydraulic similitude, based on Froude's Law, were used to convert model dimensions and hydraulic quantities to prototype equivalents as follows:

<u>Characteristic</u>	<u>Dimension*</u>	<u>Model:Prototype</u>
Length	L	$L_R = 1:20$
Area	L_R^2	$A_R = 1:400$
Velocity	$L_R^{1/2}$	$V_R = 1:4.4721$
Discharge	$L_R^{5/2}$	$Q_R = 1:1788.85$
Time	$L_R^{1/2}$	$T_R = 1:4.4721$

* Dimensions are in terms of length.

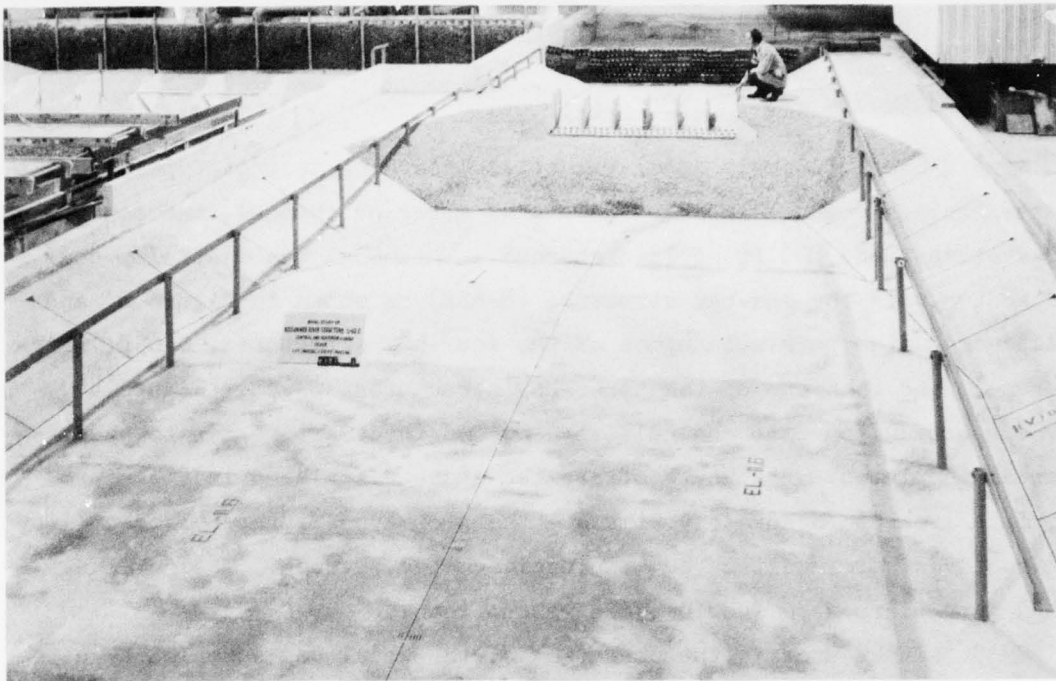


Figure 2. Downstream view of 6-bay model facility,
Structure S-65E



Figure 3. Downstream view of 4-bay model facility,
Structure S-65D

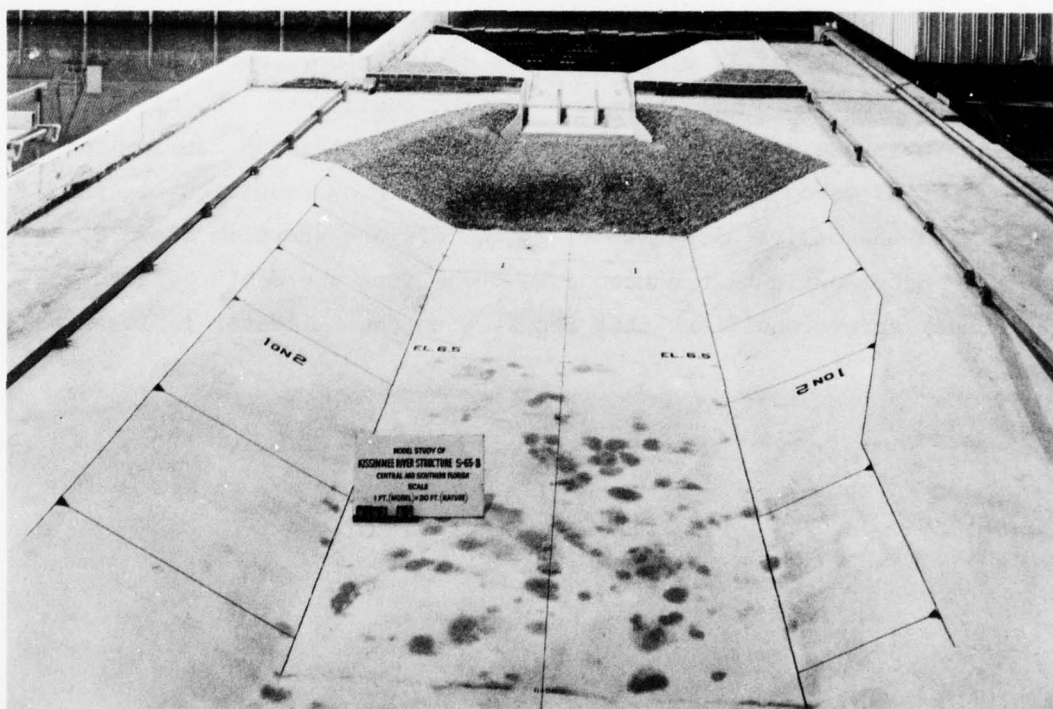


Figure 4. Downstream view of 3-bay model facility,
Structure S-65B

PART III: TESTS AND RESULTS

Structure S-65E

Riprap tests

7. Initial tests were conducted to determine the adequacy of the riprap protection downstream from Structure S-65E (Figure 5). This is the only prototype structure that has baffle blocks in the stilling basin. Details of this structure are shown in Plate 1. Tests indicated that the existing baffle arrangement is satisfactory, since no scour of the riprap occurred during normal operating conditions. No riprap movement was observed downstream from the prototype structure during the high flows of October 1969 shown in Photo 1. Flow conditions in the model with the design discharge of 24,000 cfs are shown in Photo 2.

8. Scour could be produced downstream from the S-65E structure only under spray conditions that result when the tailwater is lower than

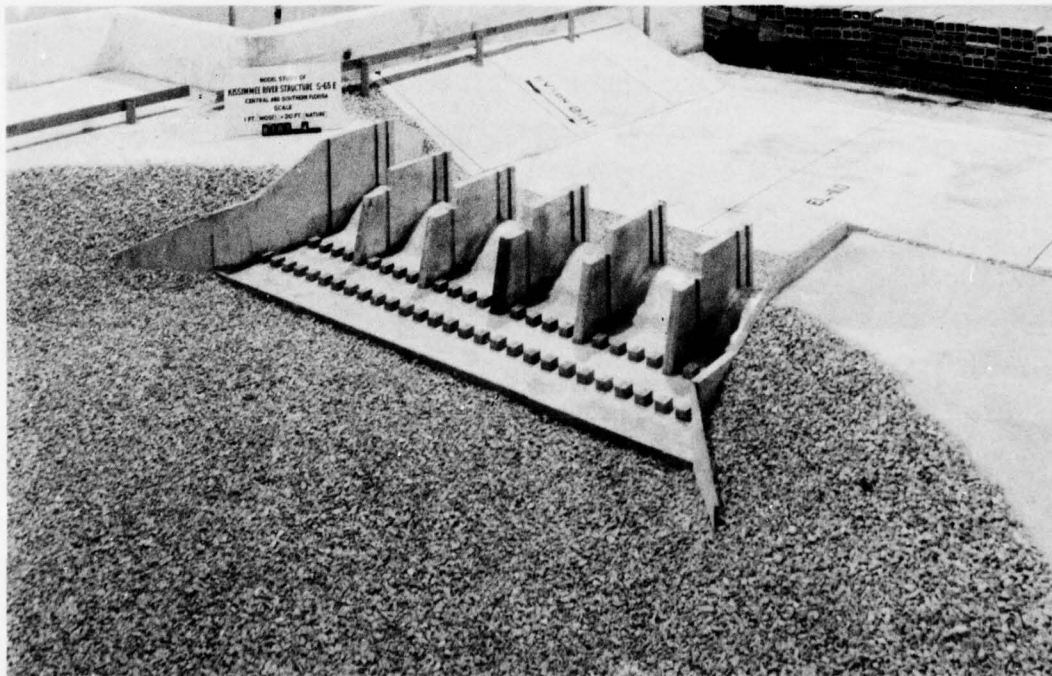


Figure 5. Stilling basin and downstream riprap, model structure S-65E

that required to maintain hydraulic jump action in the stilling basin. Plate 2 illustrates the tailwater elevations that permitted spray with various gate openings subject to the normal pool elevations of 21.0 ft.* Safe operation of S-65E should result with normal pool elevation, gate opening, and tailwater combinations that fall above the line shown in Plate 2.

Discharge calibration tests

9. Tests to determine the discharge characteristics of Structure S-65E were conducted for the following flow conditions.

- a. Free uncontrolled flow. Gates fully open; upper pool unaffected by the tailwater.
- b. Submerged uncontrolled flow. Gates fully open; upper pool controlled by the submergence effect of the tailwater.
- c. Free controlled flow. Gates partially open; upper pool unaffected by the tailwater; controlled by the particular gate opening.
- d. Submerged controlled flow. Gates partially open; upper pool controlled by both the submergence effect of the tailwater and the gate opening.

10. Free uncontrolled-flow characteristics were determined by introducing various constant discharges into the model and observing the corresponding upper pool elevation. Sufficient time was allowed for stabilization of the upstream flow conditions. Upper pool elevations were measured at a point 200 ft upstream from the spillway. Tailwater elevations were measured at a point 400 ft downstream of the end sill.

11. A similar procedure was followed for various gate openings to determine the discharge characteristics of free controlled flow.

12. Submerged-flow characteristics for both controlled and uncontrolled flows were determined by introducing several constant discharges into the model and varying the tailwater from an elevation at which no interference with spillway flow was evident to an elevation at which the flow was highly submerged. The elevation of the upper pool for each tailwater elevation was recorded.

13. Basic data obtained are presented in plots of approach channel

* All elevations (el) are in feet referred to mean sea level (msl).

energy elevation (water surface plus velocity head based on average velocity) versus tailwater elevation. These data are shown in Plates 3-8.

14. The flow conditions and equations used to satisfy the calibration data are identified as follows:

a. Free uncontrolled flow:

$$Q = CLH_e^{3/2}, \text{ where } C \text{ is a function of } H_e$$

b. Submerged uncontrolled flow:

$$Q = C_s Lh \sqrt{2g\Delta H}, \text{ where } C_s \text{ is a function of } h/H_e$$

c. Free controlled flow:

$$Q = C_g L G_o \sqrt{2gH_g}, \text{ where } C_g \text{ is a function of } H_g \text{ and } G_o$$

d. Submerged controlled flow:

$$Q = C_{g_s} Lh \sqrt{2g\Delta H}, \text{ where } C_{g_s} \text{ is a function of } h/G_o$$

Symbols used in these equations are defined as follows:

Q = total discharge, cfs

C = discharge coefficient for free uncontrolled flow

L = net length of spillway crest, ft

H_e = total energy head on weir, ft

C_s = discharge coefficient for submerged uncontrolled flow

h = tailwater elevation referred to weir crest, ft

g = acceleration due to gravity, ft/sec²

ΔH = differential between total energy of the approach channel and depth of tailwater in reference to the crest in ft ($H_e - h$)

C_g = discharge coefficient for free controlled flow

G_o = gate opening, ft

H_g = total head on gate, ft ($H_e - G_o/2$)

C_{g_s} = discharge coefficient for submerged controlled flow

15. Known quantities determined from the basic data were substituted in the equations, and the discharge coefficients for the respective flow conditions were computed. These coefficients are shown in Plates 9-12.

Structure S-65D

16. Structure S-65D (Figure 6) was selected as a typical four-bay

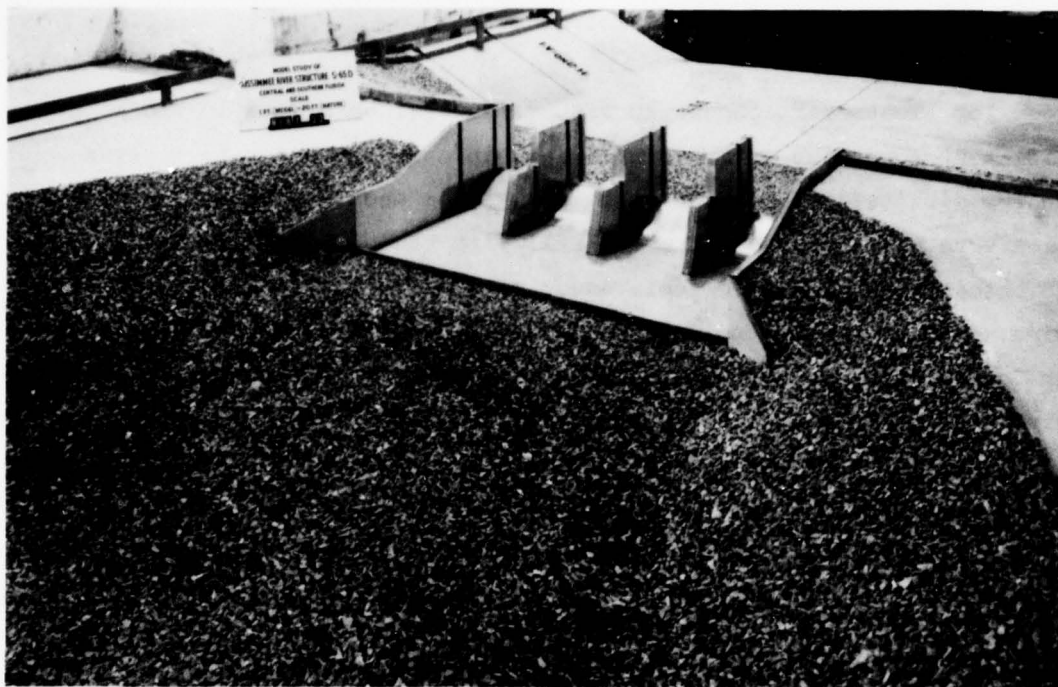


Figure 6. Stilling basin and downstream riprap, model structure S-65D, Type 1 design (prototype)

structure for model testing. Tests were conducted with a range of head-water and tailwater conditions so that results would be applicable to either of the four-bay structures. Details of Structure S-65D are shown in Plate 13. This structure does not have baffle blocks in the stilling basin and heavy scour damage occurred downstream during the high flows in 1969 (see Photo 3). Two alternatives were considered to remedy this problem: baffle blocks could be added on the stilling basin apron or the size of the protective stone downstream could be increased.

Operation of existing structures

17. Information was needed to determine a safe range of operation of the existing structures until corrective measures could be implemented. These data are shown in Plate 14 and were obtained by setting a gate opening and maintaining a constant pool while the tailwater was gradually lowered until movement of the existing 18-in. riprap occurred. Safe operation will result if tailwater and gate opening combinations

fall above a selected normal pool line.

Baffle block tests

18. Tests were conducted with various sizes of baffle blocks at different locations on the stilling basin apron in order to increase energy dissipation and reduce the downstream scour potential. Velocities were measured above the end sill with the design flow conditions to obtain the relative effectiveness of each type of baffle block design. Table 1 lists the different baffle designs that were tested and the velocities measured. The average velocity over the end sill measured at el 9.0 was used to compare the efficiency of each design in reducing the potential for downstream scour. The Type 5 (two rows of 3.5-ft-high baffles) and Type 15 (two rows of 4.3-ft-high baffles) designs resulted in the lowest average velocities at el 9.0. Plates 15, 16, and 17 show velocities measured with the Type 1 (prototype), Type 5, and Type 15 designs. The designs of Types 5 and 15 resulted in satisfactory flow conditions and velocities downstream. However, the baffles were slightly smaller with the Type 5 design (Figure 7), and it was recommended for the prototype modification. The design consisted of two rows of 3.5-ft-high baffles located 32 and 41 ft downstream from the toe of the spillway crest. The baffles were 3 ft wide and spaced 3 ft apart. Flow conditions with the Type 5 design are shown in Photo 4. Minimum safe operating conditions obtained with this design and the existing 18-in. riprap are shown in Plate 18.

Riprap tests

19. Tests were conducted with larger riprap downstream from the original basin to determine the size required for stability with the critical hydraulic conditions shown in the operations log. This condition for Structure S-65D was selected from the log entry dated 5 October 1969. On this date, the headwater was at el 31.14, the tailwater was at el 23.20, and the gate opening was at el 10. In order to verify that this condition would cause riprap failure, a test was conducted with the existing 18-in. riprap for a simulated time of 2 hr (26.83-min model). This flow condition in the model is shown in Photo 5. The results of this test are shown in Figure 8. The 18-in. riprap was

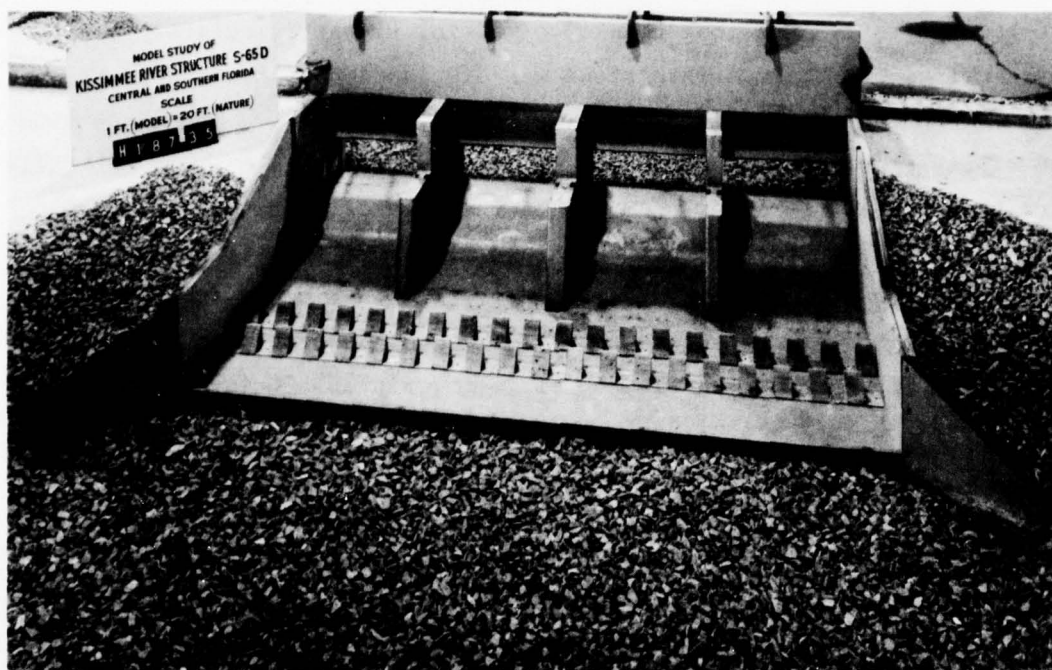


Figure 7. Stilling basin and downstream riprap, model structure S-65D with Type 5 design (3-ft-high baffles)



Figure 8. Downstream scour at model structure S-65D, Type 1 design (prototype), after 2-hr test at headwater el 31.24, tailwater el 23.20, all gates open 10 ft

replaced with a 30-ft-long blanket of 24-in. riprap immediately downstream from the basin. This stone was displaced near the end of the blanket during the test condition as shown in Figure 9. Thus, the size of riprap was increased to 36 in. This stone size was stable, but failure occurred at the downstream end of the blanket in the 18-in. riprap due to turbulence created by the larger stone. A transition blanket of 24-in. riprap was added in order to prevent this type of failure. Several lengths of each stone were tested and the best plan (Figure 10), consisted of a 50-ft-long blanket of 36-in. riprap (5¹/₂ in. thick) followed by a 30-ft reach of 24-in. riprap (36 in. thick).

Discharge calibration tests

20. Calibration tests for Structure S-65D were performed and analyzed as discussed in paragraphs 9-12. Basic data, presented as plots of approach channel energy elevation versus tailwater elevation, are shown in Plates 19-23. Discharge coefficients of Structure S-65D for the four types of flow are shown in Plates 24-27.

Structure S-65B

21. Structure S-65B (Figure 11) was selected as a typical three-bay structure for model testing. Again, tests were conducted with a range of headwater and tailwater conditions so that results would be applicable to any of the three-bay structures. Details of Structure S-65B are shown in Plate 28. None of the three-bay structures have baffle blocks in the stilling basin. Heavy scour was observed downstream from those structures after the high flows in 1969 (see Photo 6). Since SAJ had determined from an economic analysis that placing baffle blocks in the basin of the S-65D structure was less expensive than increasing the size of the downstream protection, only baffle blocks were considered as a corrective measure for the three-bay structures.

Operation of existing structures

22. Until corrective measures can be implemented, the information shown in Plate 29 was obtained as a minimum operating guide. This information was obtained by setting a gate opening and maintaining



Figure 9. Downstream scour at model structure S-65D, Type 16 design (24-in. riprap), after 2-hr test at headwater el 31.14, tailwater el 23.40, all gates open 10 ft



Figure 10. Stilling basin at model structure S-65D with Type 20 design (riprap)

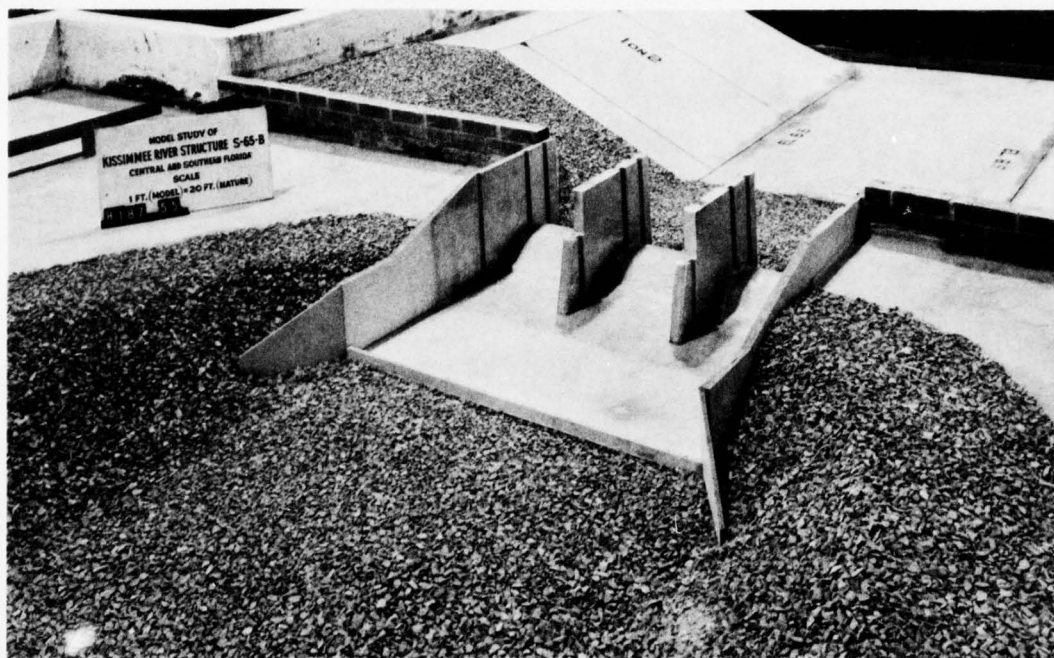


Figure 11. Stilling basin and downstream riprap, model structure S-65B, Type 1 design (prototype)

a constant pool while the tailwater was gradually lowered until movement of the existing 18-in. riprap occurred. Safe operation will result if tailwater and gate opening combinations fall above a selected normal pool line.

Baffle block tests

23. Tests were conducted with various sizes of baffle blocks at different locations in the stilling basin apron in order to increase energy dissipation and reduce the downstream scour potential. Velocities were measured above the end sill with the design flow conditions to obtain the relative effectiveness of each design. Table 2 lists the different baffle designs that were tested and the velocities measured. The average velocity over the end sill measured at el 23.0 was used to compare the efficiency of each design in reducing the potential for downstream scour. Of the designs tested, Types 19 and 25 produced the lowest average velocities at el 23.0. The existing riprap

downstream from the structure was stable for all expected flow conditions with either the Type 19 or Type 25 design and either design could be used for the prototype modification. Design flow conditions in both the Types 19 and 25 designs are shown in Photo 7.

Discharge calibration tests

24. Calibration tests for Structure S-65B were performed and analyzed as discussed in paragraphs 9-12. Basic data, presented as plots of approach channel energy elevation versus tailwater elevation, are shown in Plates 30-33. Discharge coefficients of Structure S-65B for the four types of flow are shown in Plates 34-37.

PART IV: DISCUSSION OF RESULTS AND CONCLUSIONS

25. Scour of the downstream riprap protection has been observed at several of the Kissimmee River structures. A model study was needed to determine what modifications could be made to the structures to reduce the scouring tendencies and to obtain a safe operating schedule until these modifications could be implemented. Since the structures vary in width and number of bays, three typical structures were modeled. These were S-65E, six bays; S-65D, four bays; and S-65B, three bays.

26. The only existing structure with baffle blocks in the stilling basin is S-65E. It has not experienced riprap scour downstream from the basin, and no scour was detected in the model until flow sprayed off the baffle blocks, a condition caused by extremely low tailwater. Thus, no modifications are needed at this structure.

27. None of the other structures have baffle blocks in the stilling basin and heavy scour damage occurred downstream during the high flows in 1969. To alleviate this problem, two alternatives were considered: baffle blocks could be added on the stilling basin apron or the size of the protective stone could be increased. After tests were conducted to determine the optimum size and configuration of the baffle blocks and the size and extent of riprap required, it was determined from an economical analysis that the baffle blocks would be less costly. Two rows of baffles were more effective than one in increasing energy dissipation and reducing velocities downstream. The optimum size and location of these blocks were determined for each structure.

28. Information was obtained to develop a guide for safe operation until the baffle blocks can be added. This information will allow the operator to determine a combination of headwater, tailwater, and gate opening that will not displace the existing 18-in. riprap.

29. Although model tests* had been conducted prior to these tests

* U. S. Army Engineer Waterways Experiment Station, CE, "Typical Spillway Structure for Central and Southern Florida Water Control Project, Hydraulic Model Investigation," Technical Report 2-633, Sep 63, Vicksburg, Miss.

to determine discharge characteristics for a typical spillway structure, a limited amount of discharge calibration data were obtained for each of the structures. Discharge coefficients obtained were very close to those shown in the referenced report.

Table 1
Kissimmee River S-65D, Baffle Block Tests

Design Type	Baffle Block Height ft	Spacing Between Blocks ft	Location Down- stream of Toe		Average Velocities Taken above End Sill (Sta 0+88 D/S)		
			1st Row ft	2nd Row ft	El 9.0 ft/sec	El 15.5 ft/sec	El 22.0 ft/sec
1	--	--	--	--	16.5	13.3	8.2
2	3.5	3.0	32.0	--	11.3	14.4	10.4
3	3.5	3.0	27.0	--	11.7	14.5	11.0
4	3.5	3.0	37.0	--	11.3	14.8	10.5
5	3.5	3.0	32.0	41.0	9.3	14.8	11.5
6	3.5	3.0	27.0	36.0	9.7	14.7	11.4
7	2.7	2.7	22.0	--	11.9	14.4	10.1
8	2.7	2.7	17.0	--	13.0	14.0	10.3
9	2.7	2.7	27.0	--	12.1	14.3	9.9
10	2.7	2.7	27.0	34.0	10.3	14.8	9.4
11	2.7	2.7	32.0	39.0	10.3	15.0	10.6
12	4.3	4.0	27.0	--	11.5	14.4	11.3
13	4.3	4.0	27.0	38.0	9.7	14.7	12.1
14	4.3	4.0	32.0	--	11.4	14.8	11.2
15	4.3	4.0	32.0	43.0	9.2	15.1	12.1

Table 2
Kissimmee River S-65B, Baffle Block Tests

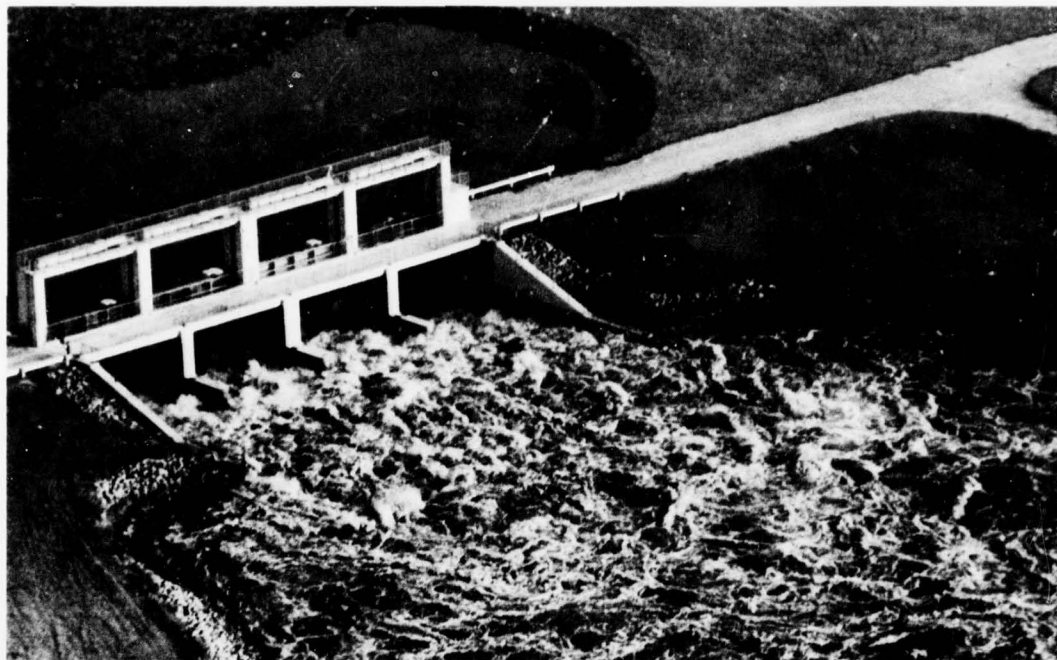
Design Type	Baffle Block Height ft	Spacing Between Blocks ft	Location Down- stream of Toe		Average Velocities Taken above End Sill (Sta 0+83 D/S)		
			1st Row ft	2nd Row ft	El 23.0 ft/sec	El 15.5 ft/sec	El 22.0 ft/sec
1	--	--	--	--	17.1	13.7	8.7
2	3.14	3.14	29.0	--	12.0	14.8	11.1
3	3.14	3.14	24.0	--	12.2	14.3	10.9
4	3.14	3.14	24.0	32.0	10.7	14.8	11.9
5	3.14	3.14	29.0	37.0	10.3	15.4	11.9
6	3.14	3.14	34.0	42.0	10.0	15.2	11.6
7	3.14	3.14	34.0	--	11.4	14.6	10.6
8	2.75	2.75	29.0	--	12.0	14.5	10.6
9	2.75	2.75	24.0	--	12.0	14.4	10.9
10	2.75	2.75	34.0	--	11.9	14.5	10.4
11	2.75	2.75	34.0	41.0	10.5	15.1	11.1
12	2.75	2.75	29.0	36.0	10.3	15.1	11.6
13	2.75	2.75	24.0	31.0	10.6	15.0	11.8
14	3.67	3.67	29.0	--	11.3	14.8	11.5
15	3.67	3.67	24.0	--	11.7	14.7	11.7
16	3.67	3.67	34.0	--	11.1	15.0	11.2
17	3.67	3.67	29.0	38.0	10.0	15.2	12.6
18	3.67	3.67	24.0	33.0	10.6	15.0	12.6
19	3.67	3.67	34.0	43.0	9.5	15.3	12.3
20	4.40	4.40	29.0	--	11.0	14.9	11.9
21	4.40	4.40	24.0	--	11.5	14.6	12.0
22	4.40	4.40	34.0	--	10.7	15.2	12.2
23	4.40	4.40	29.0	40.0	10.2	14.8	12.9
24	4.40	4.40	24.0	35.0	9.7	15.3	13.5
25	4.40	4.40	34.0	44.0	9.2	15.7	13.6



Photo 1. Structure S-65E, headwater el 21.49, tailwater el 16.12, all gates open 9 ft



Photo 2. Structure S-65E, design flow conditions, headwater el 22.4, tailwater el 20.0, all gates open full



a. Prototype



b. Model

Photo 3. Structure S-65D, headwater el 30.15, tailwater el 21.4, all gates open 10 ft



a. Normal flow conditions, headwater el 26.8, tailwater el 21.0,
all gates open 4.0 ft



b. Design flow conditions, headwater el 28.0, tailwater el 23.4,
all gates open full

Photo 4. Flow conditions with Type 5 design in Structure S-65D

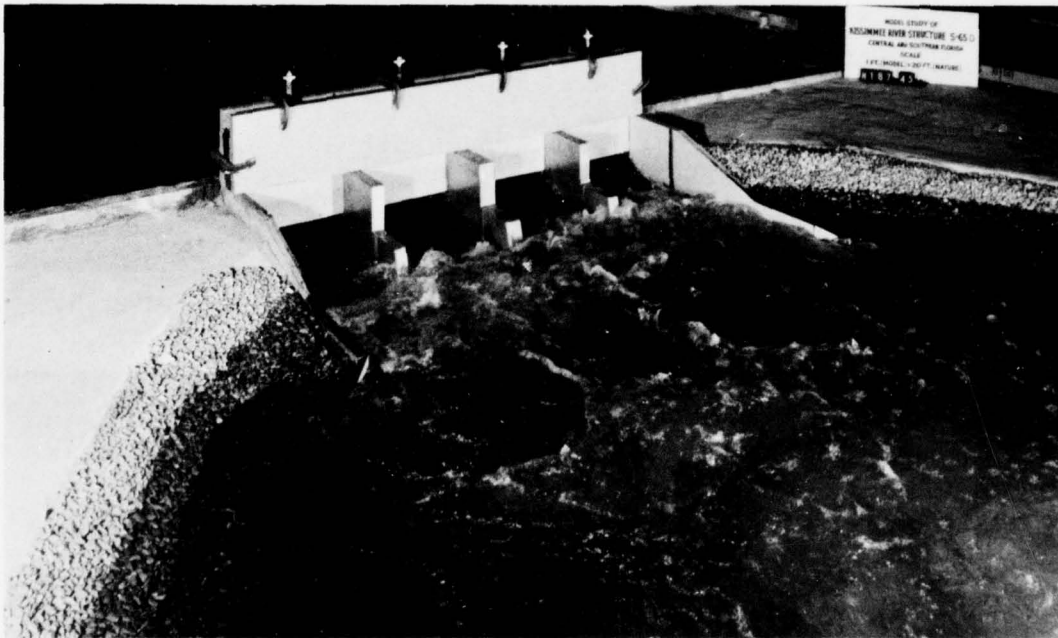
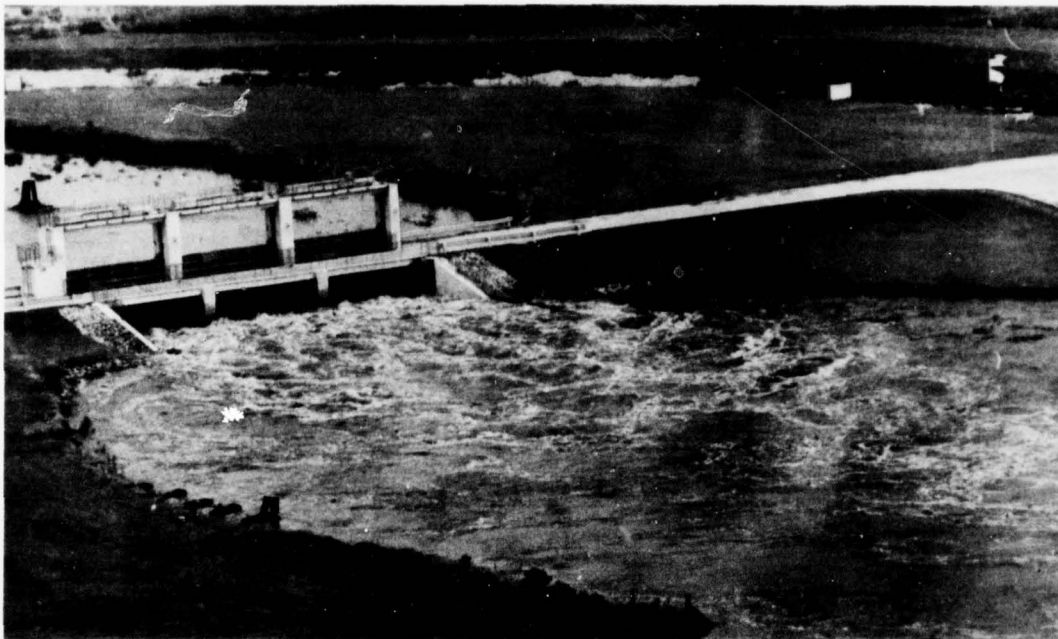


Photo 5. Structure S-65D, headwater el 30.15, tailwater el 21.4,
all gates open 10 ft

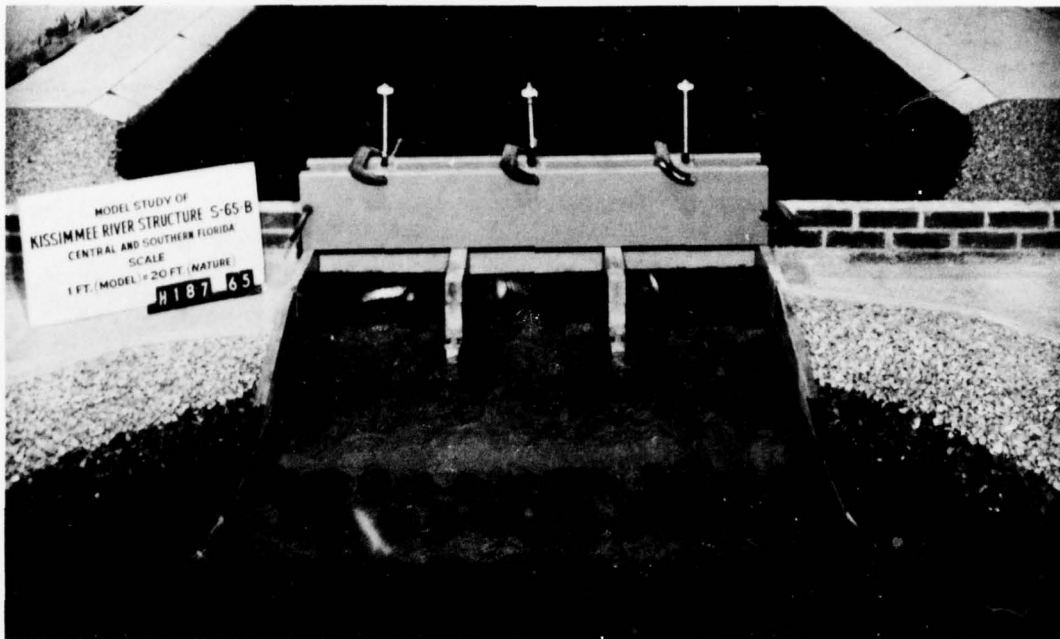


a. Prototype

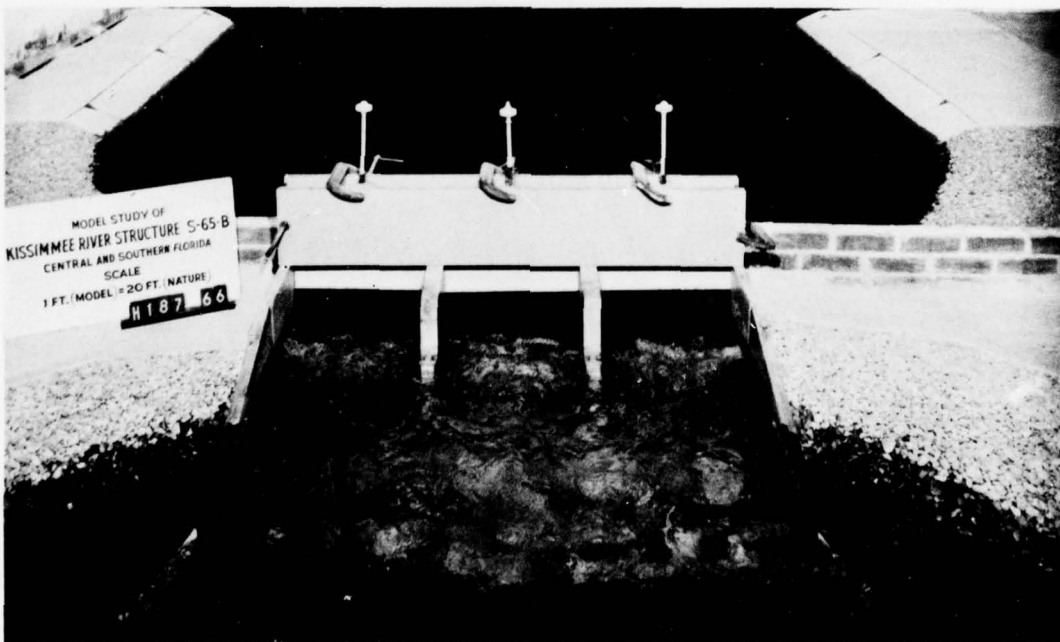


b. Model

Photo 6. Structure S-65B, headwater el 43.08, tailwater el 39.55,
all gates open 12 ft



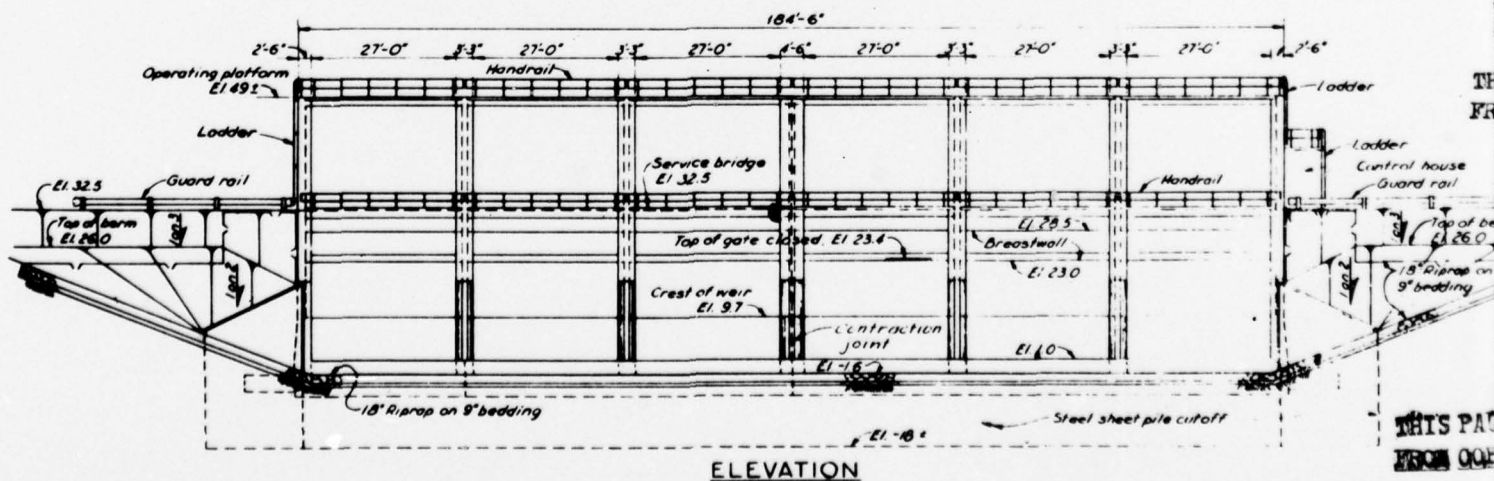
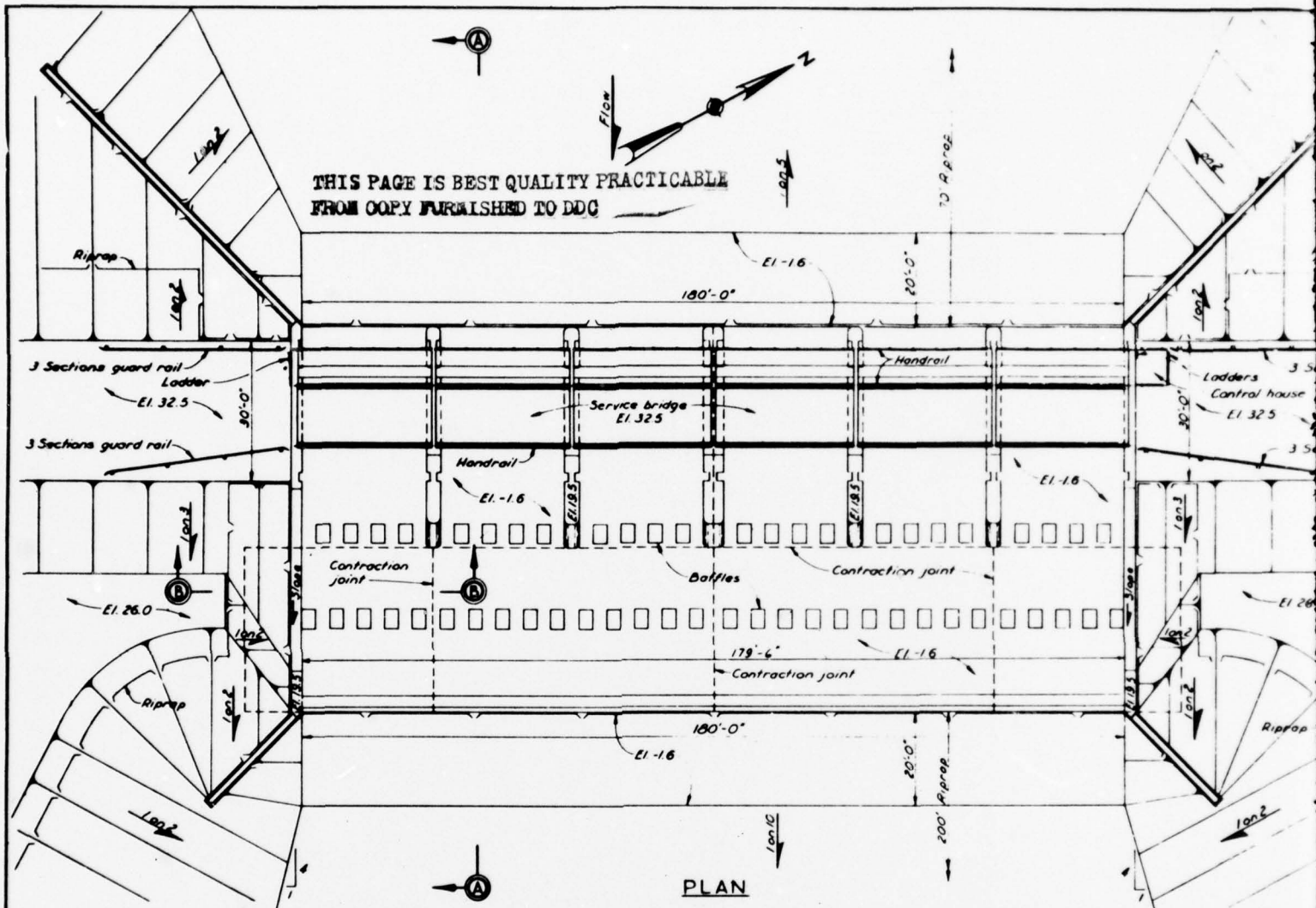
a. Type 19 design stilling basin



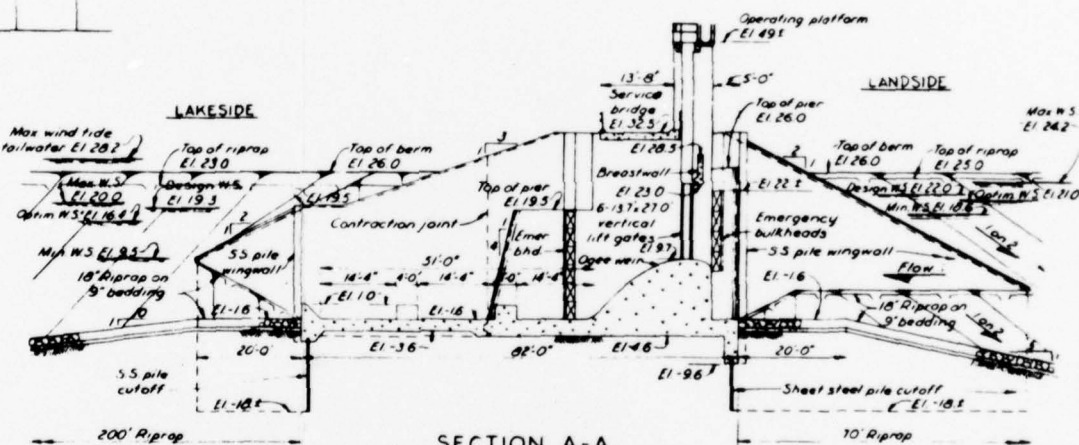
b. Type 25 design stilling basin

Photo 7. Design flow conditions in Structure S-65B, headwater el 40.0, tailwater el 35.7, 14,000 cfs

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDG



SECTION B-B



SECTION A-A


Hand-drawn sketch of a building section. The sketch includes the following labels and features:

- Top left:** "6"
- Top center:** "THIS PAGE IS BEST FROM COPY FARELS"
- Left side:** "Ladder" (pointing to a vertical structure) and "Control house" (pointing to a small structure).
- Center:** "Guard rail" (pointing to a horizontal line) and "Top of beam" (pointing to a horizontal line).
- Right side:** "Top of riprap" (pointing to a sloped area) and "Top of riprap" (pointing to a sloped area).
- Bottom center:** "18" Riprap on 5' bedding" (pointing to a sloped area).
- Elevations:** "El 32.5" (near the top right), "El 26.0" (near the top center), and "El 23.0" (near the bottom right).

STRUCTURE 65E
PLAN AND SECTIONS

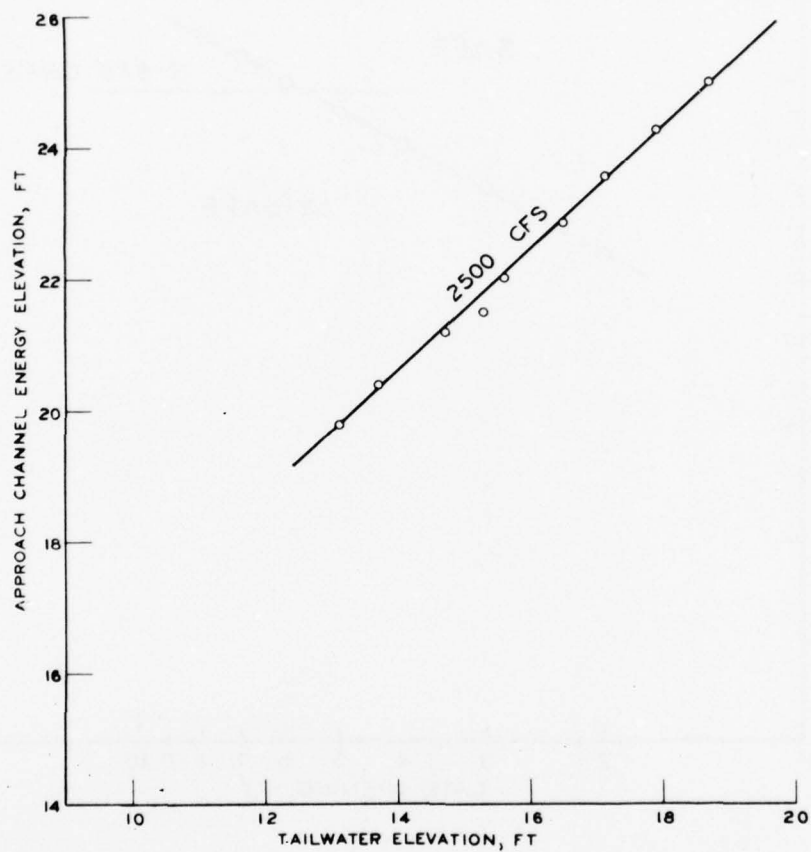
SCALE IN FEET

8' 4' 0 8 16' 24'

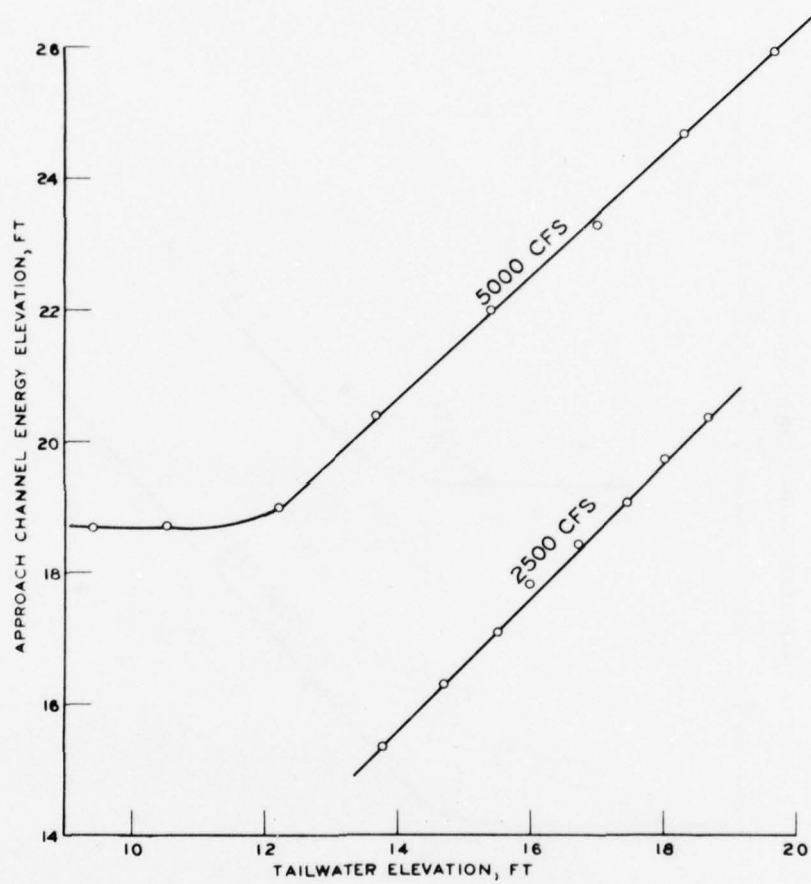




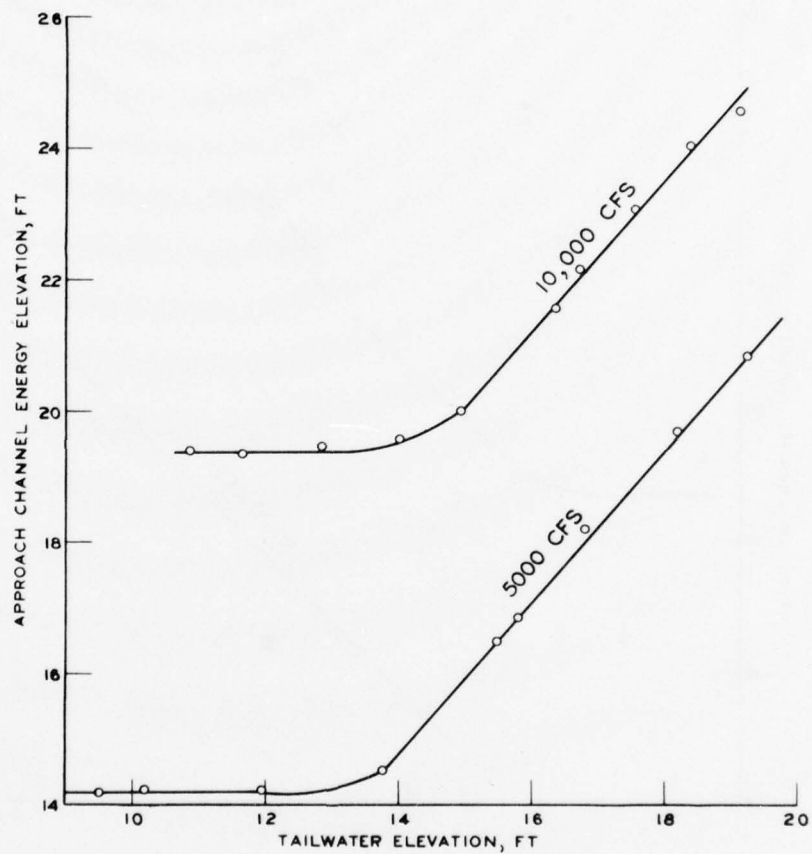
SPRAY CURVE S-65E
GATE OPENING VERSUS
TAILWATER TO PRODUCE SPRAY
MINIMUM OPERATING CONDITIONS



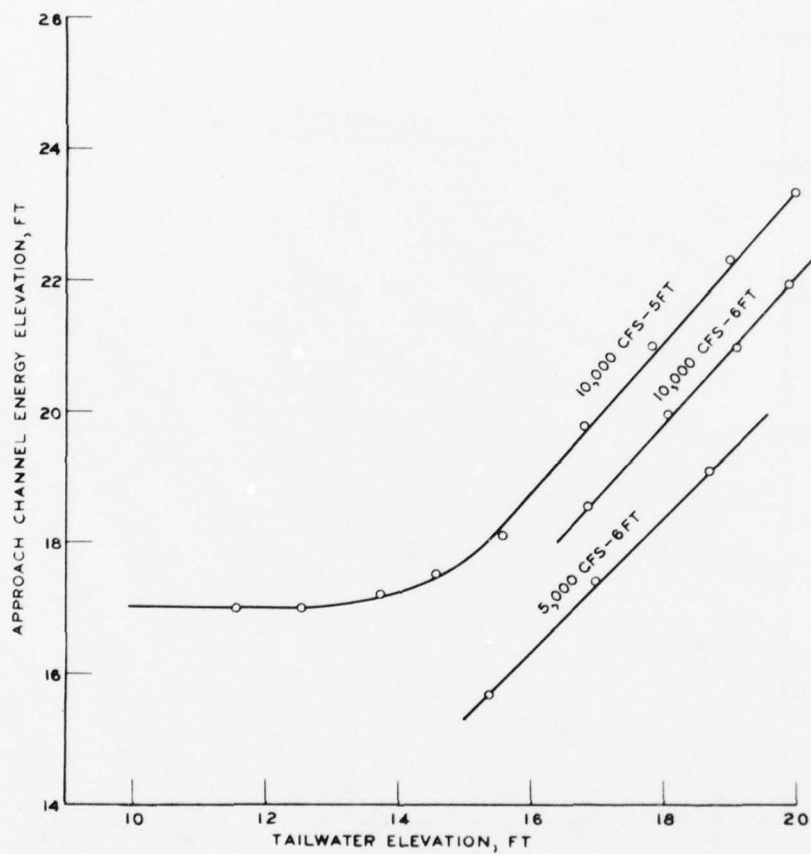
KISSIMMEE RIVER S-65E
CALIBRATION DATA
ONE-FT GATE OPENING



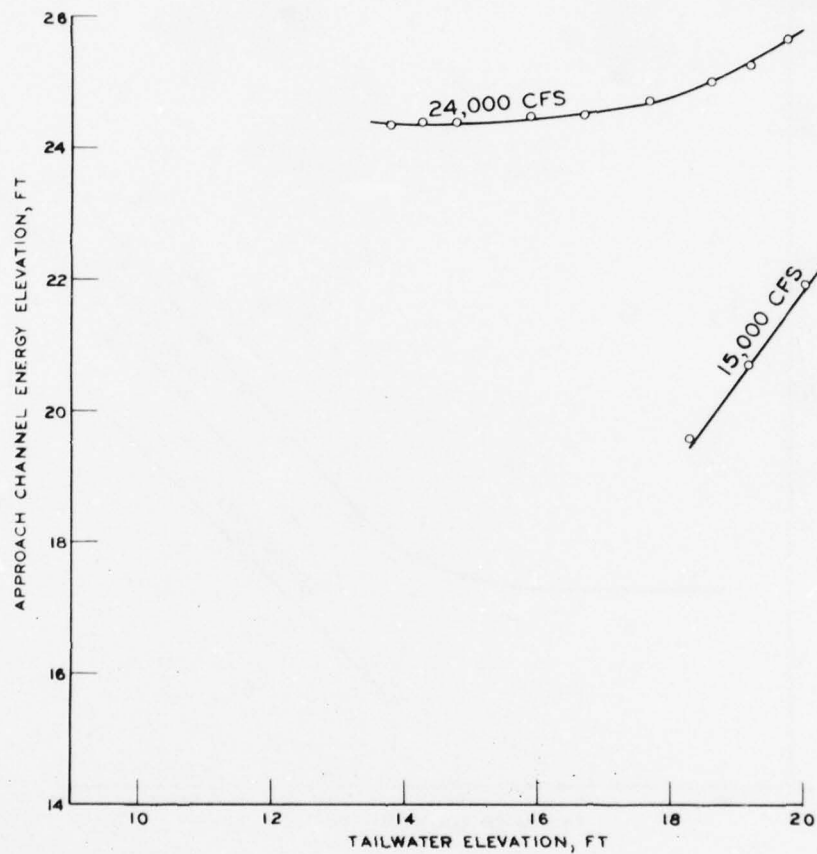
KISSIMMEE RIVER S-65E
CALIBRATION DATA
TWO-FT GATE OPENING



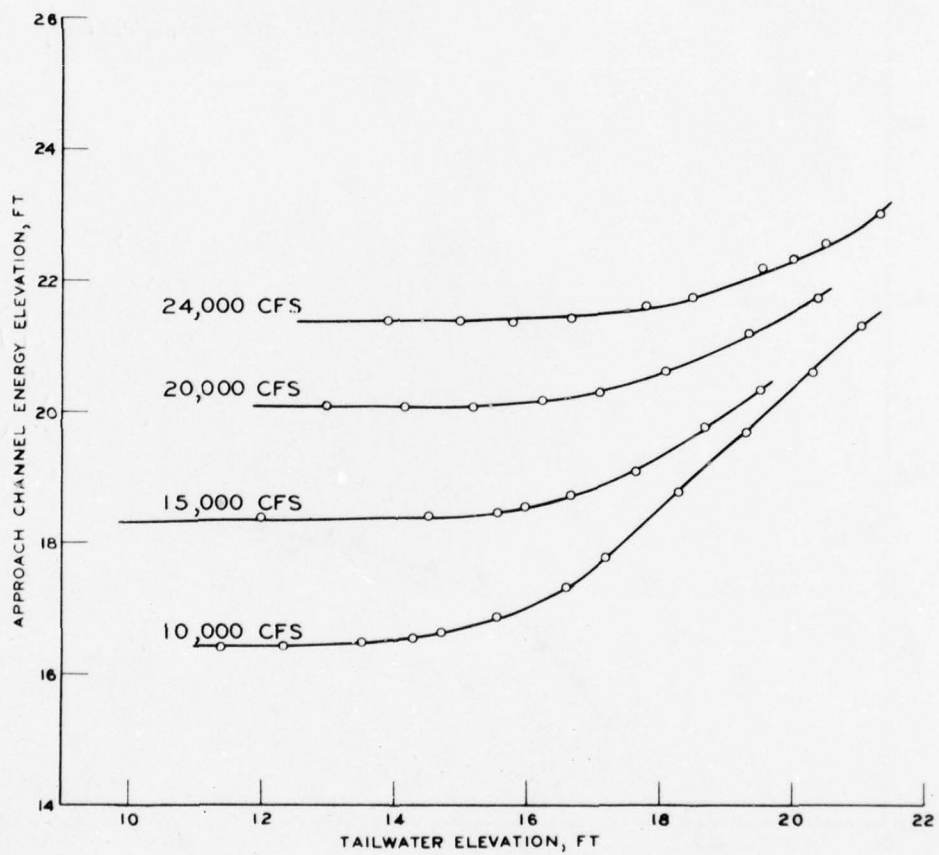
KISSIMMEE RIVER S-85E
CALIBRATION DATA
FOUR-FT GATE OPENING



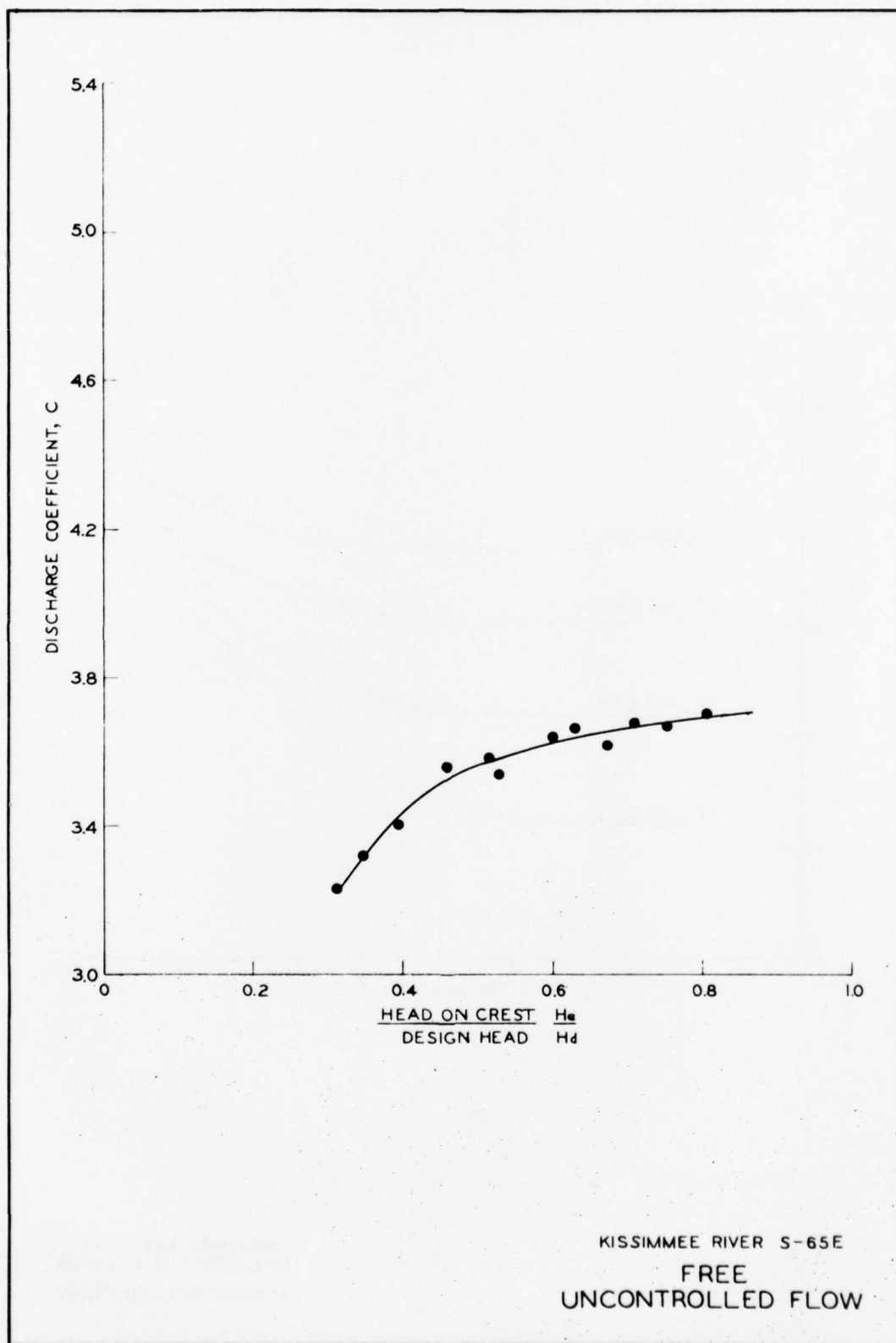
KISSIMMEE RIVER S-65E
CALIBRATION DATA
FIVE-AND SIX-FT
GATE OPENING

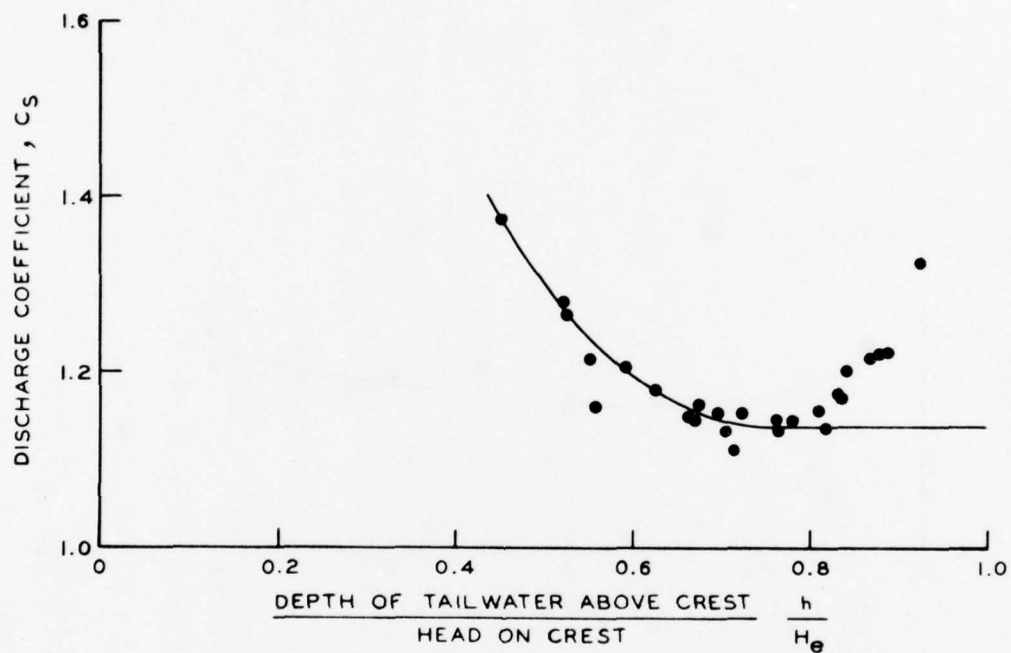


KISSIMMEE RIVER S-85E
CALIBRATION DATA
EIGHT-FT GATE OPENING

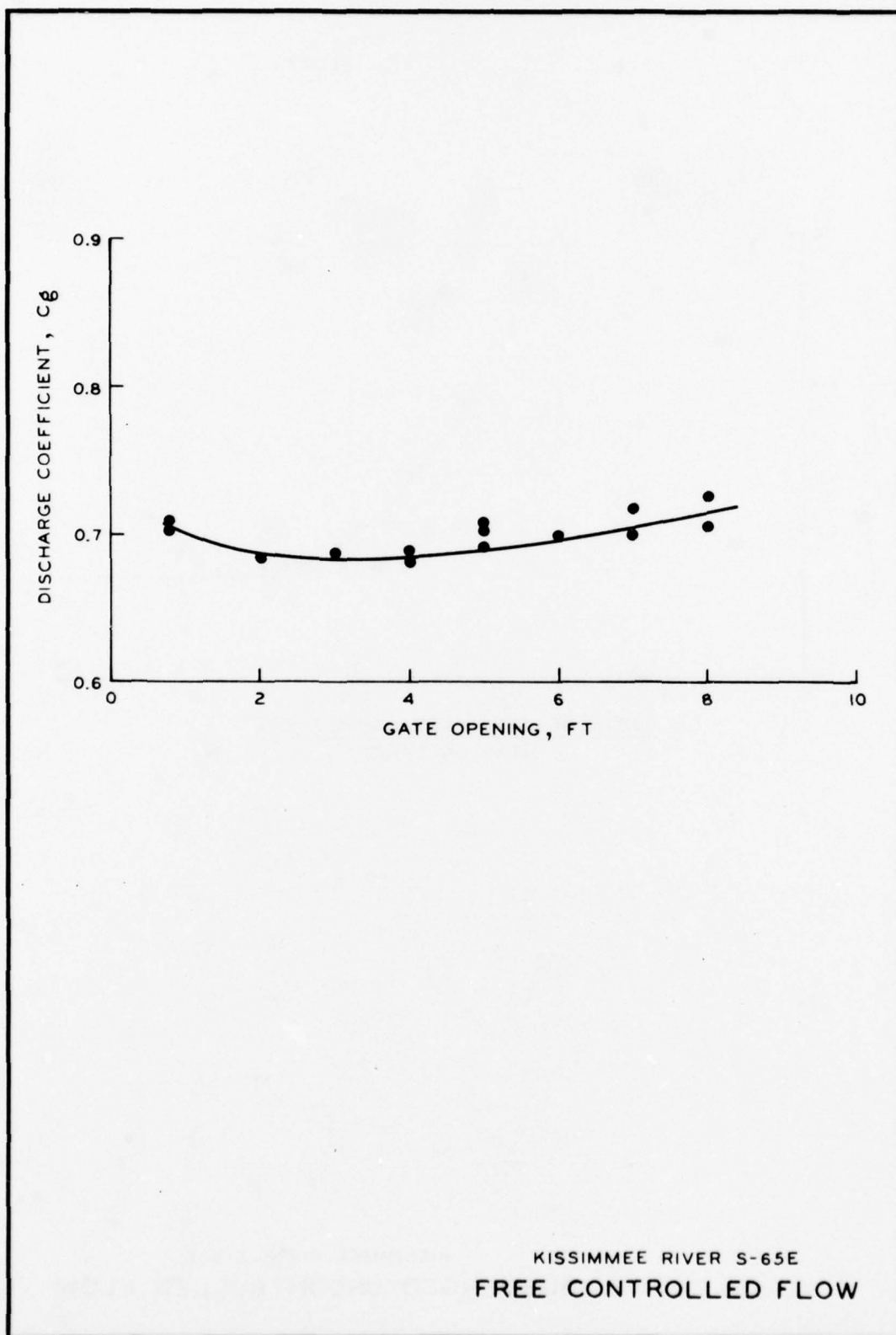


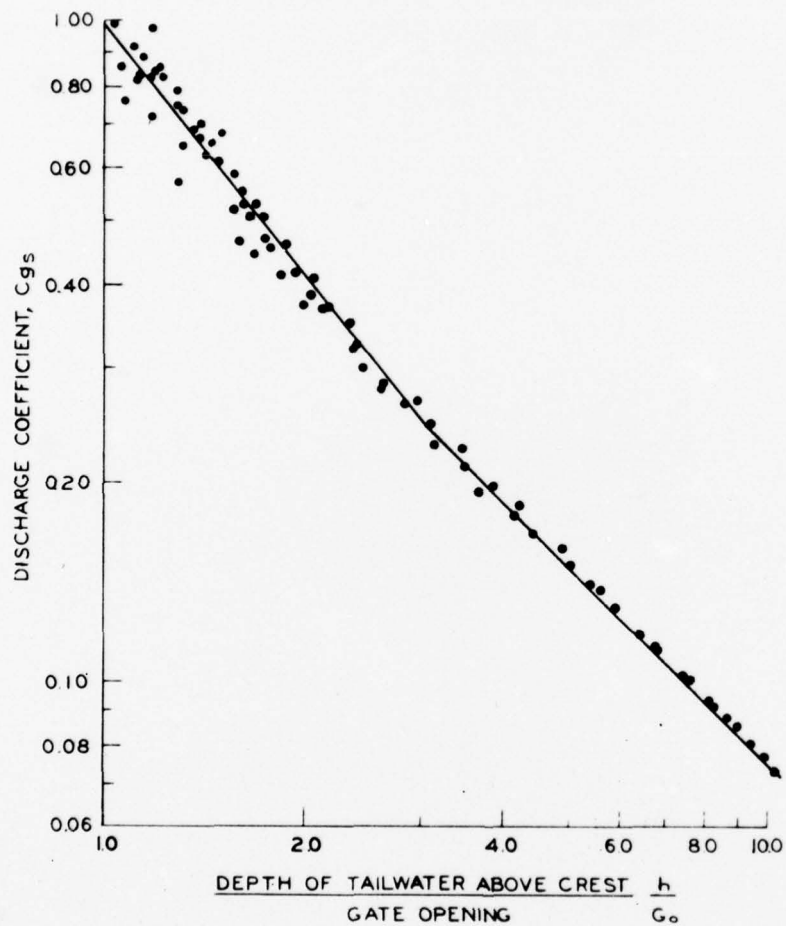
KISSIMMEE RIVER S-65E
CALIBRATION DATA
UNCONTROLLED FLOW





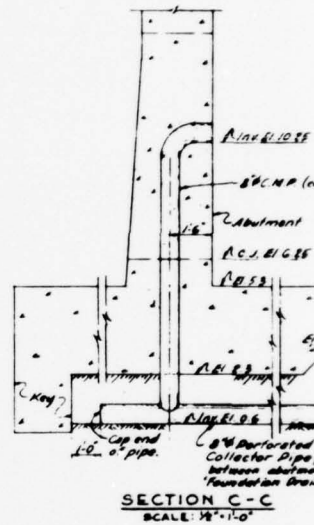
KISSIMMEE RIVER S-65E
SUBMERGED UNCONTROLLED FLOW



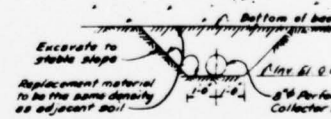


KISSIMMEE RIVER S-65E
SUBMERGED CONTROLLED FLOW

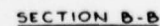
THIS PAGE IS BEST QUALITY
FROM COPY FURNISHED TO



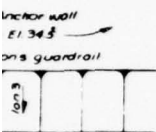
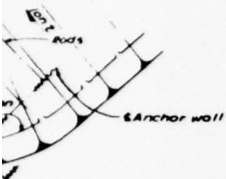
SECTION C-C
SCALE: 1/2" = 1'-0"



FOUNDATION DRAINAGE DET
SCALE: $\frac{1}{2}" = 1'-0"$

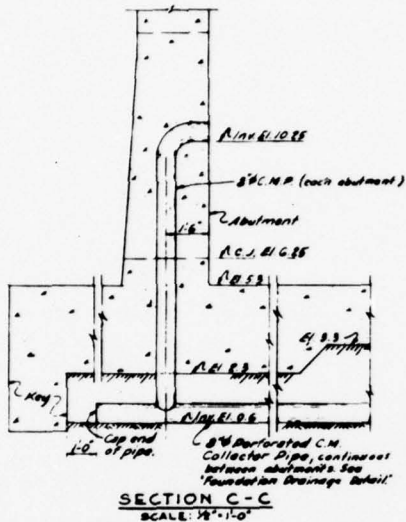


THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

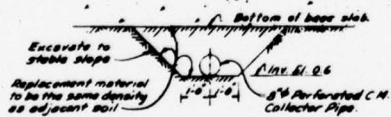


Anchor wall

10

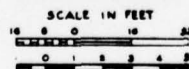


SECTION C-C
SCALE: 1/8" = 1'-0"

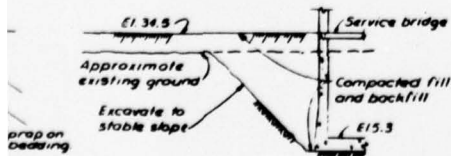


FOUNDATION DRAINAGE DETAIL
SCALE: 1/8" = 1'-0"

GRAPHIC SCALES

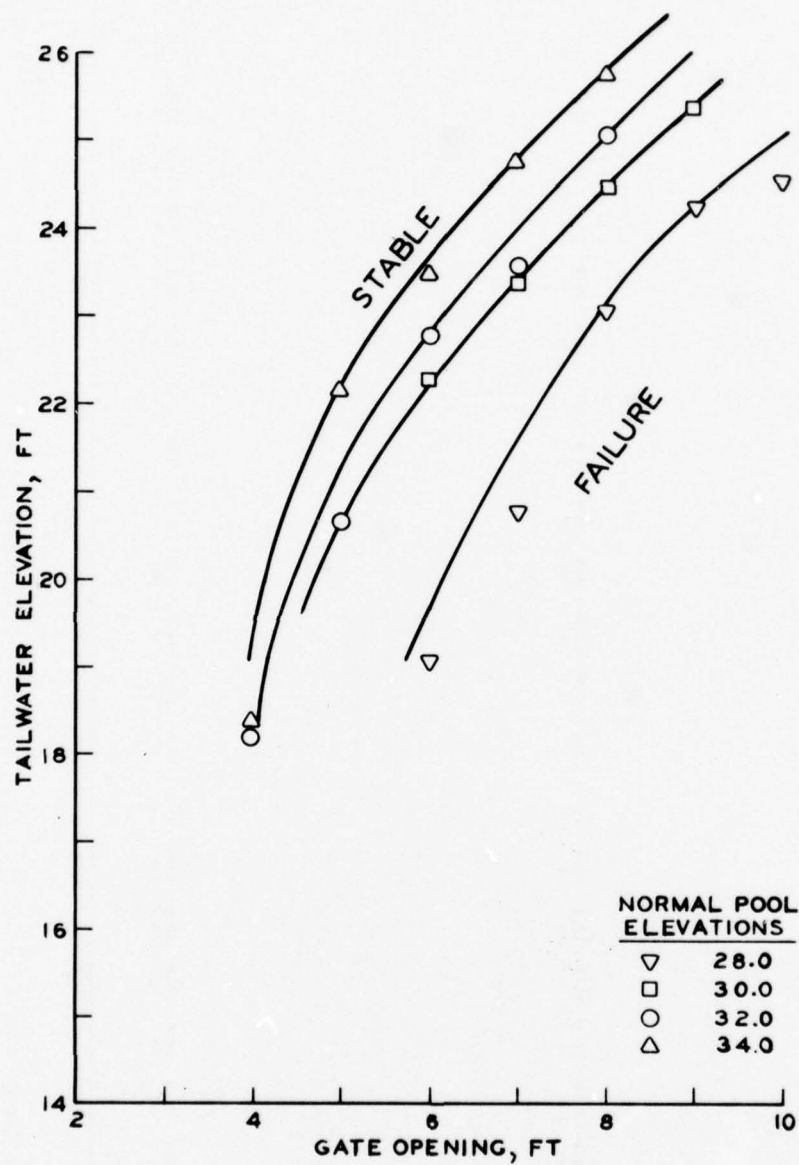


not be removed
the opening.



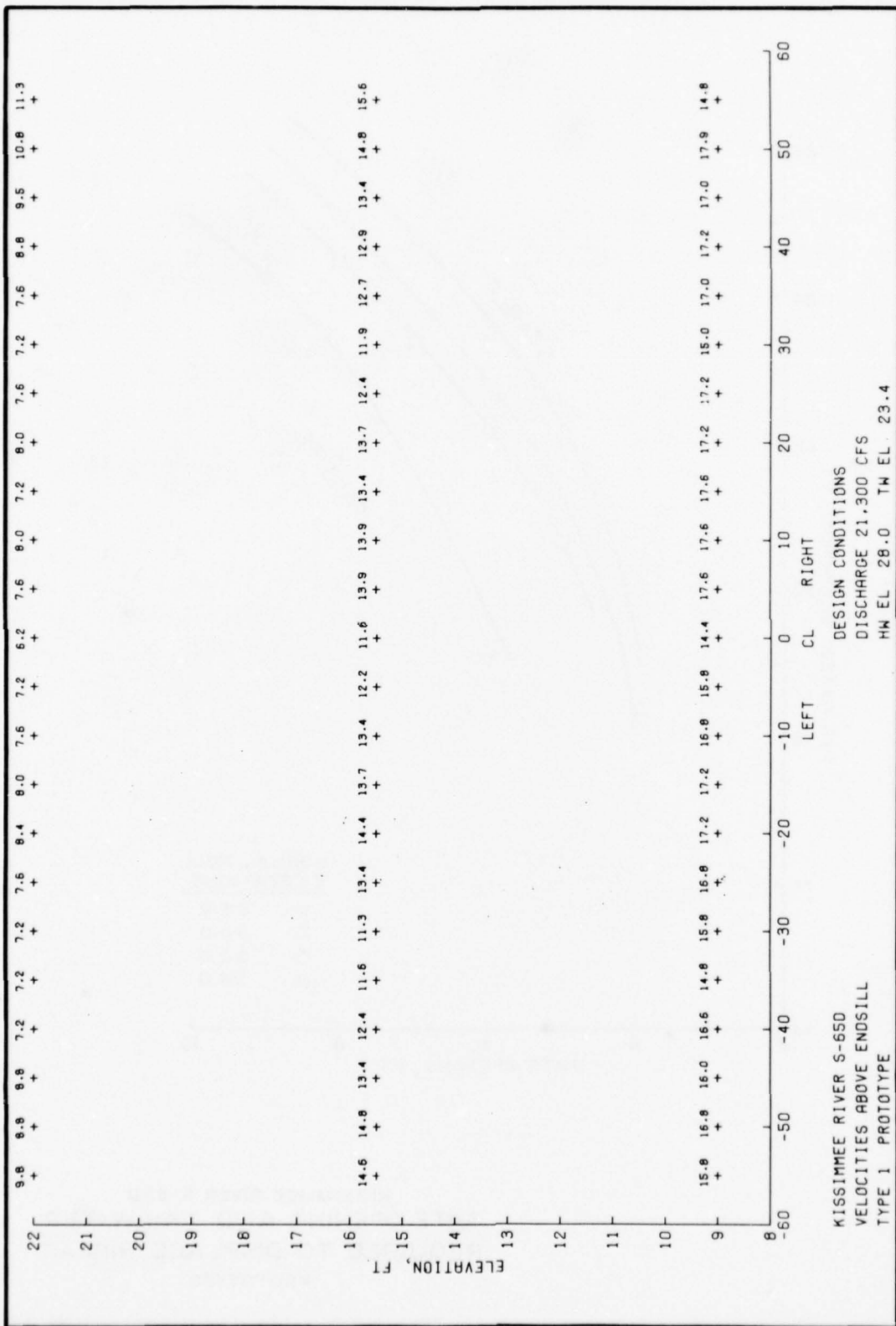
SECTION B-B

SPILLWAY PLAN AND SECTIONS
STRUCTURE 65D



KISSIMMEE RIVER S-65D
GATE OPENING AND TAILWATER
REQUIRED TO DISPLACE RIPRAP
PROTOTYPE

PLATE 15



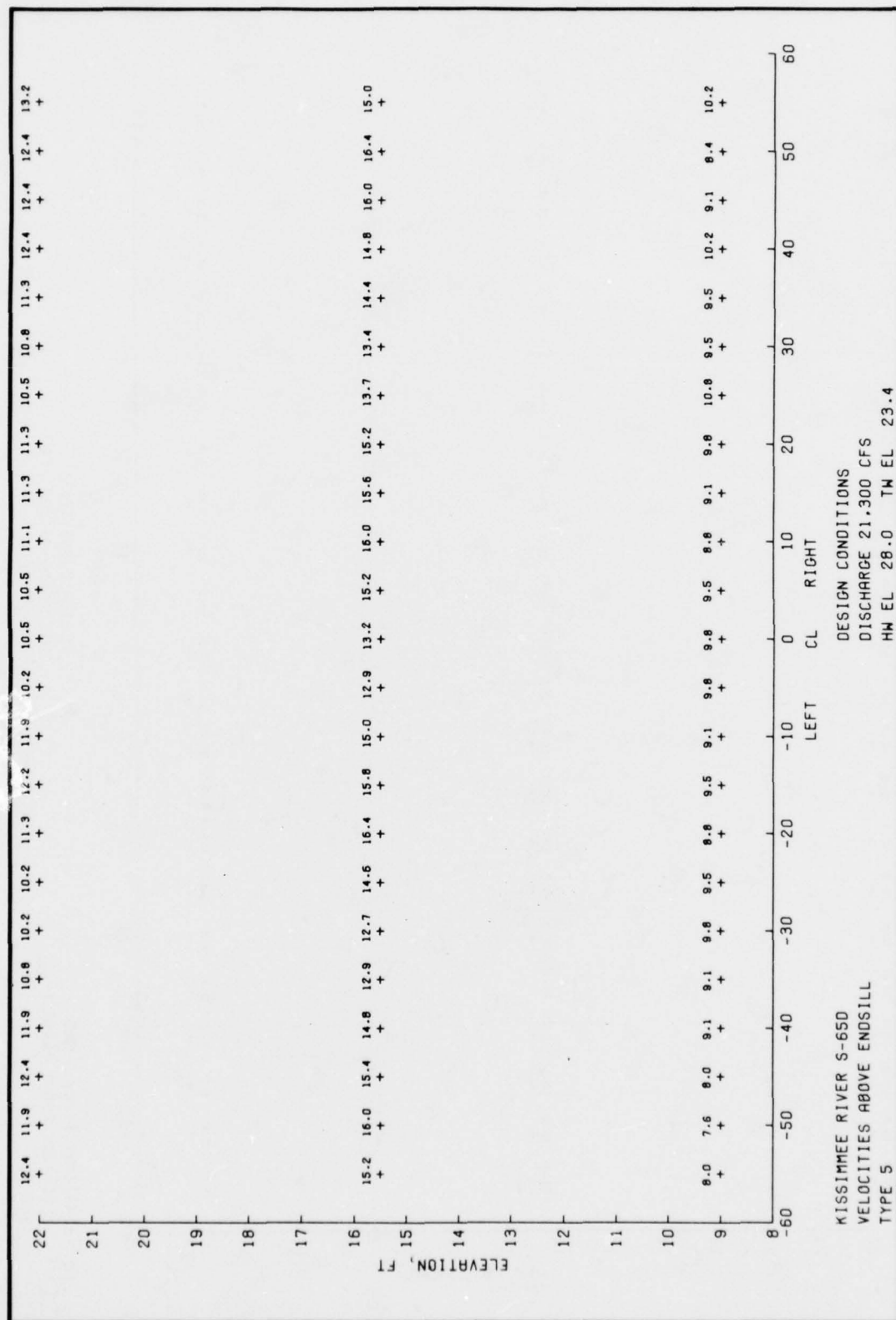
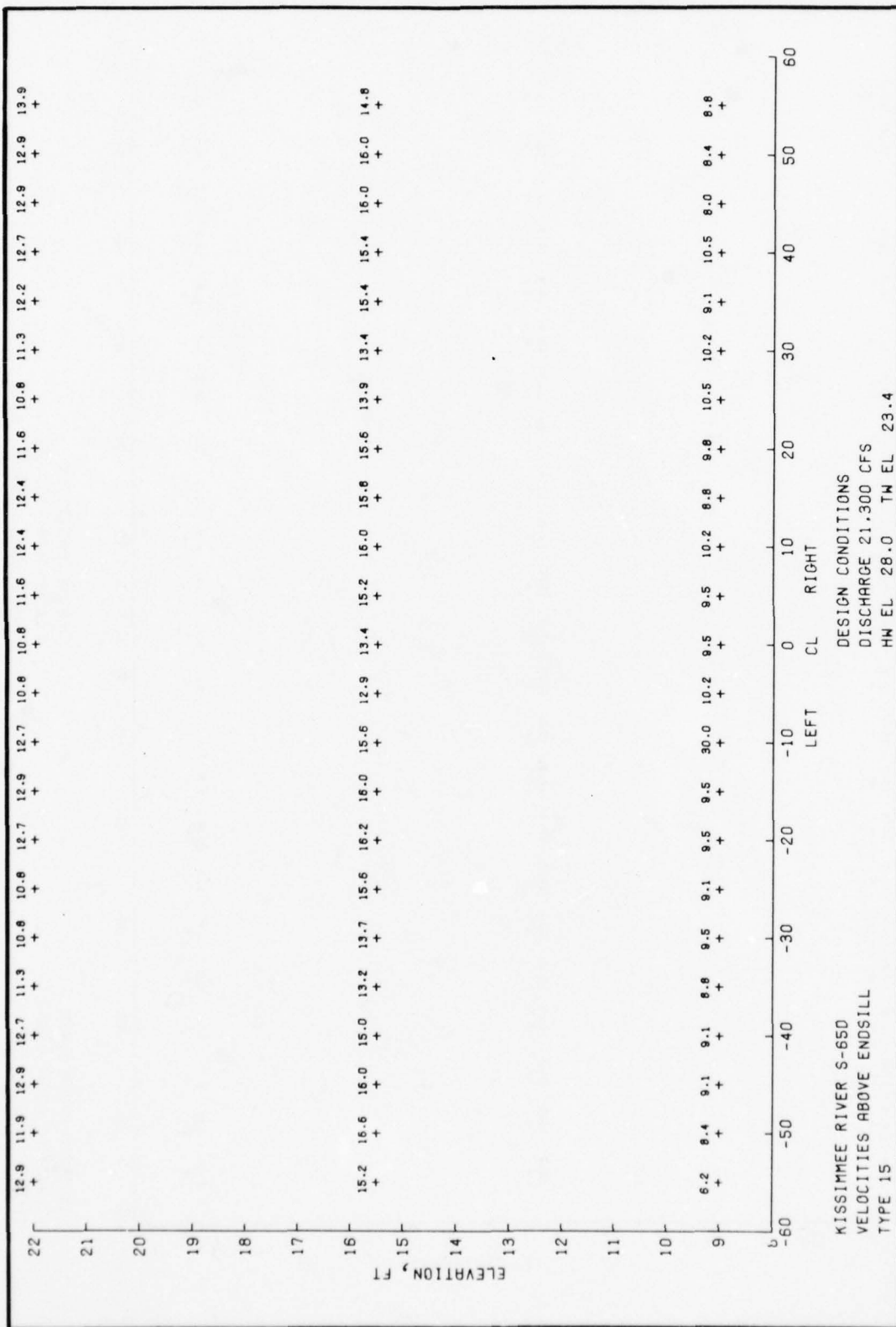
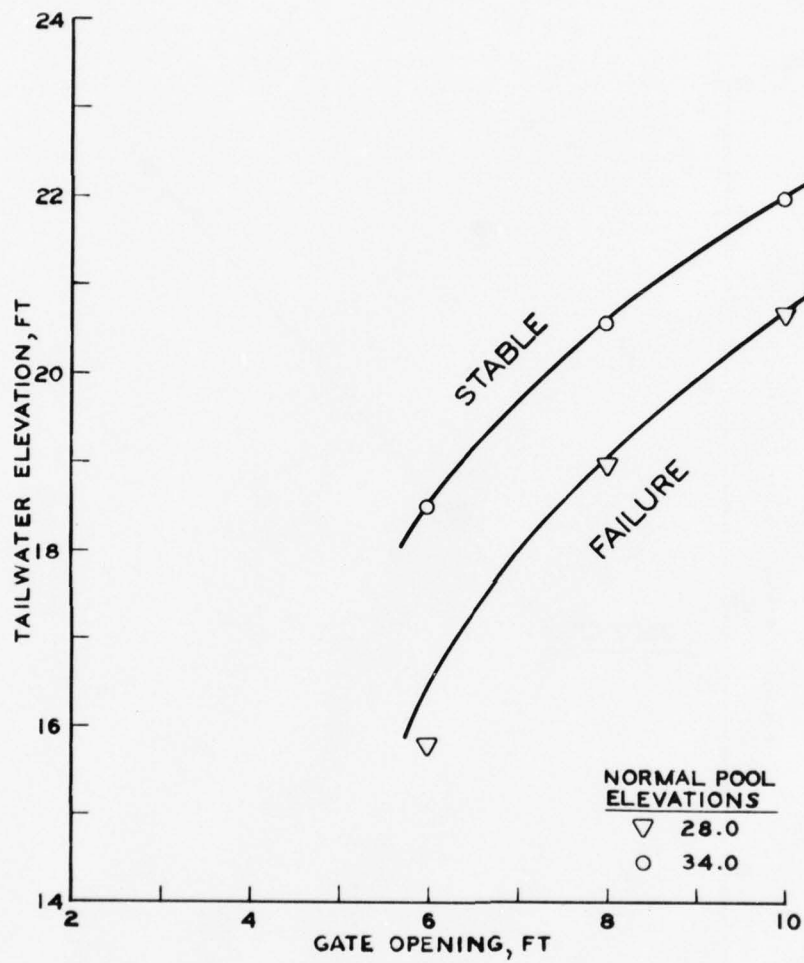
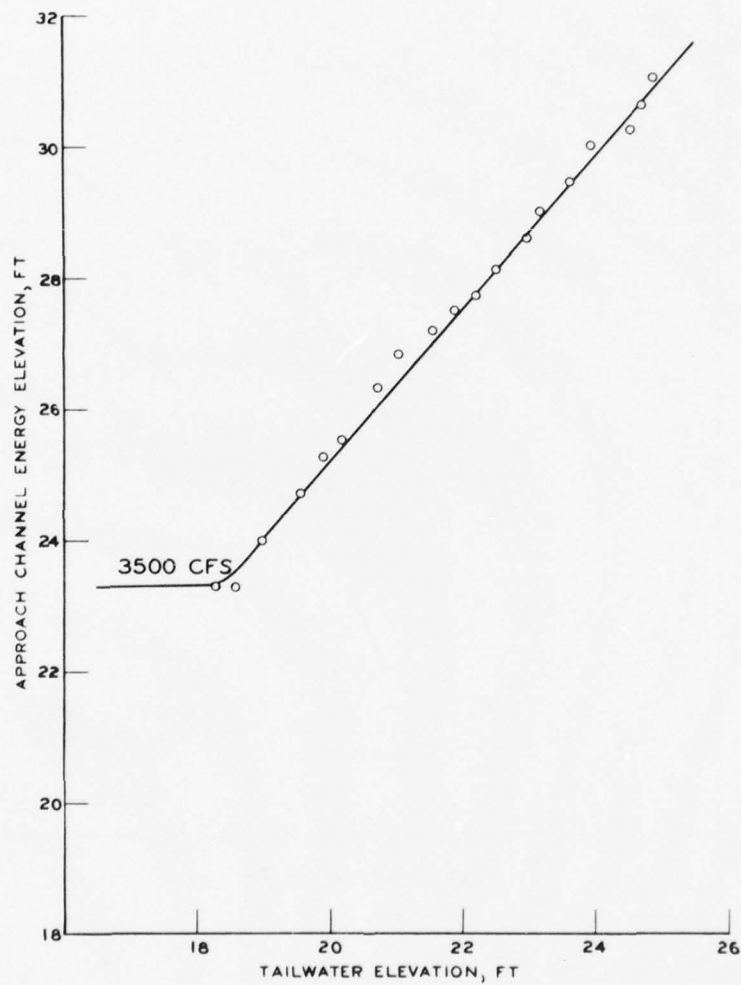


PLATE 17

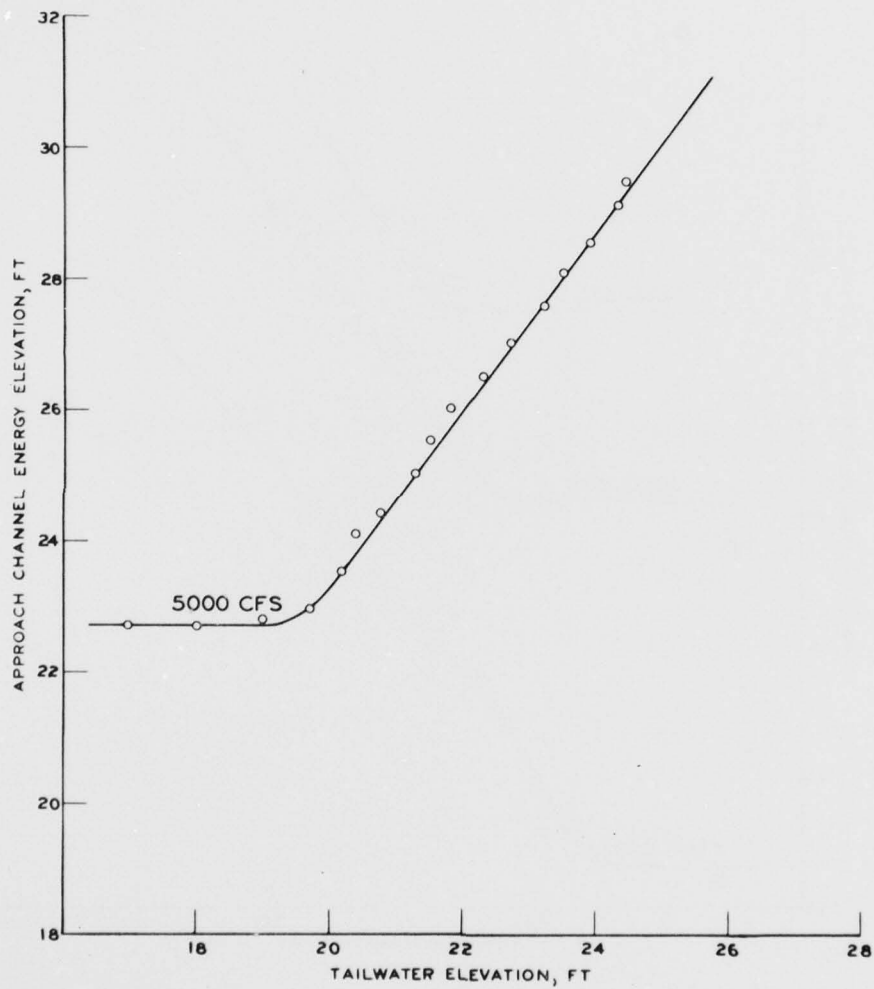




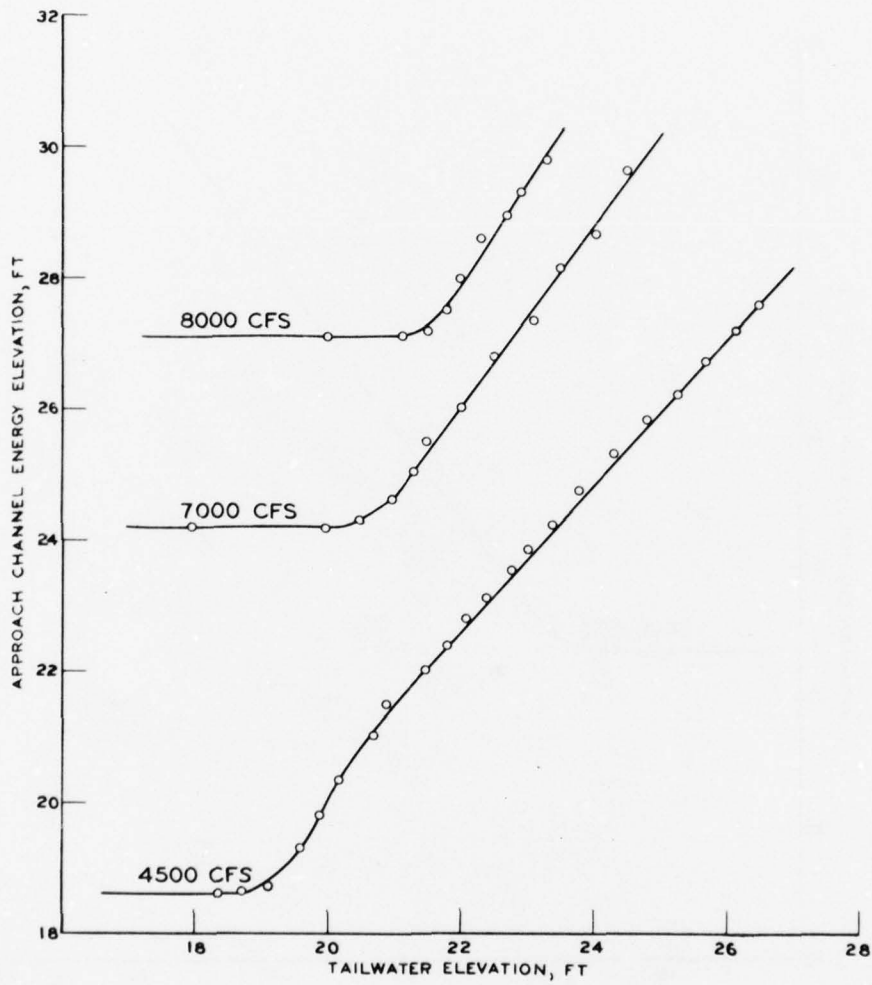
KISSIMMEE RIVER S-65D
GATE OPENING AND TAILWATER
REQUIRED TO DISPLACE RIPRAP
TYPE 5 STILLING BASIN



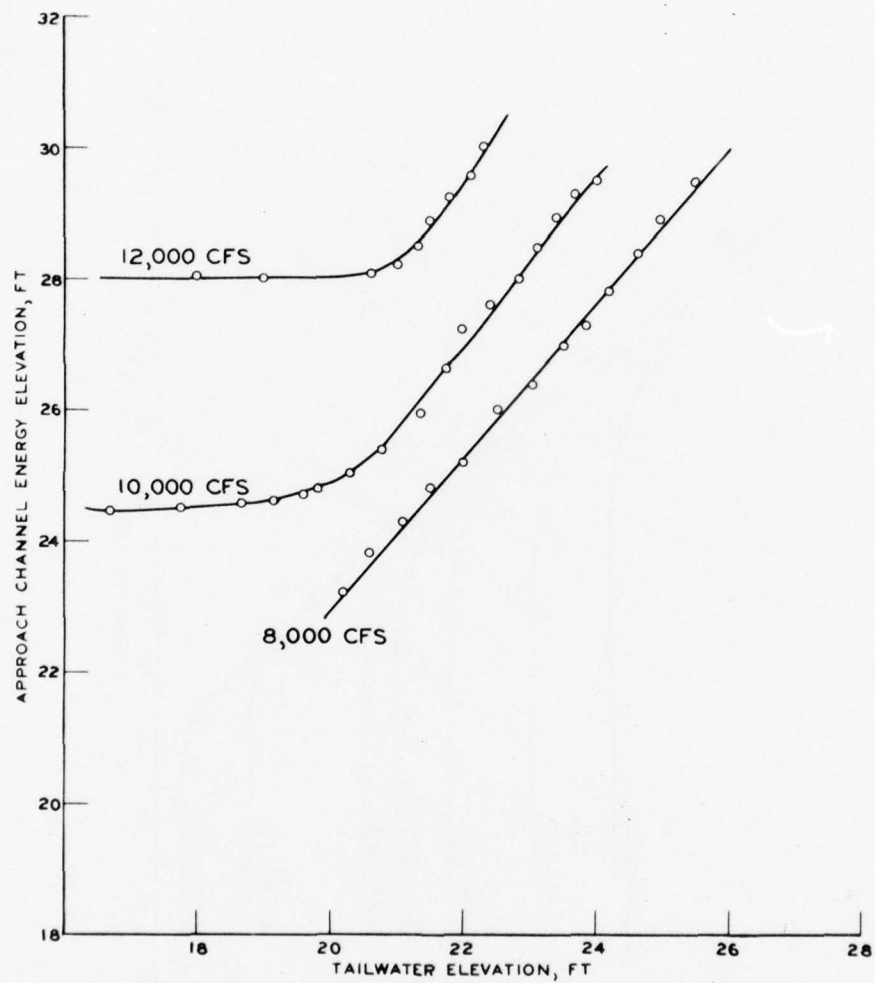
KISSIMMEE RIVER S-65D
CALIBRATION DATA
TWO-FT GATE OPENING



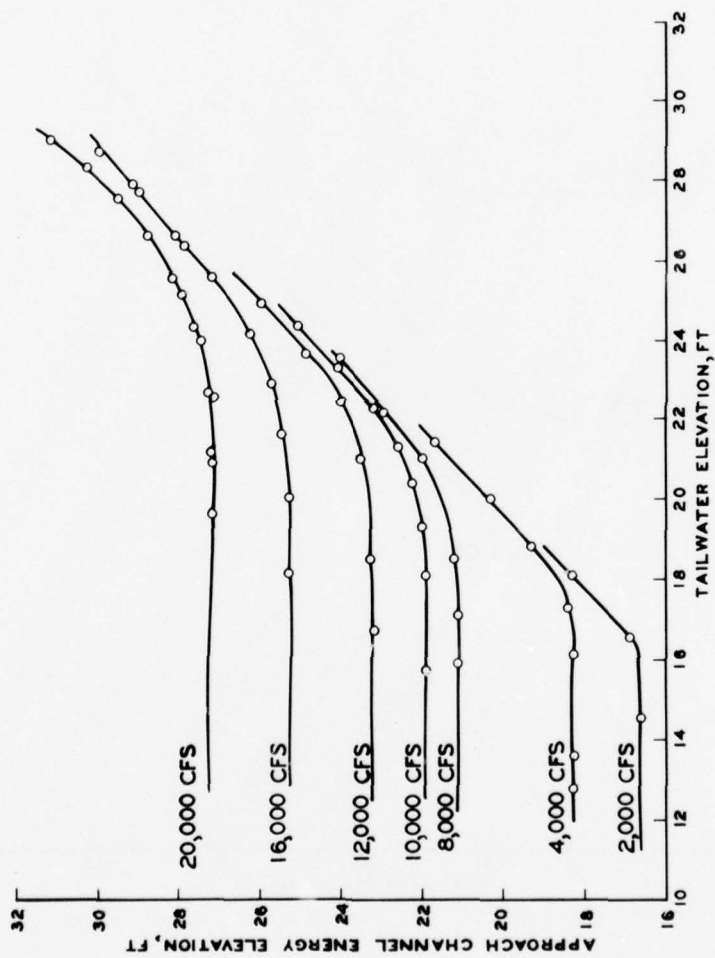
KISSIMMEE RIVER S-65D
CALIBRATION DATA
THREE-FT GATE OPENING



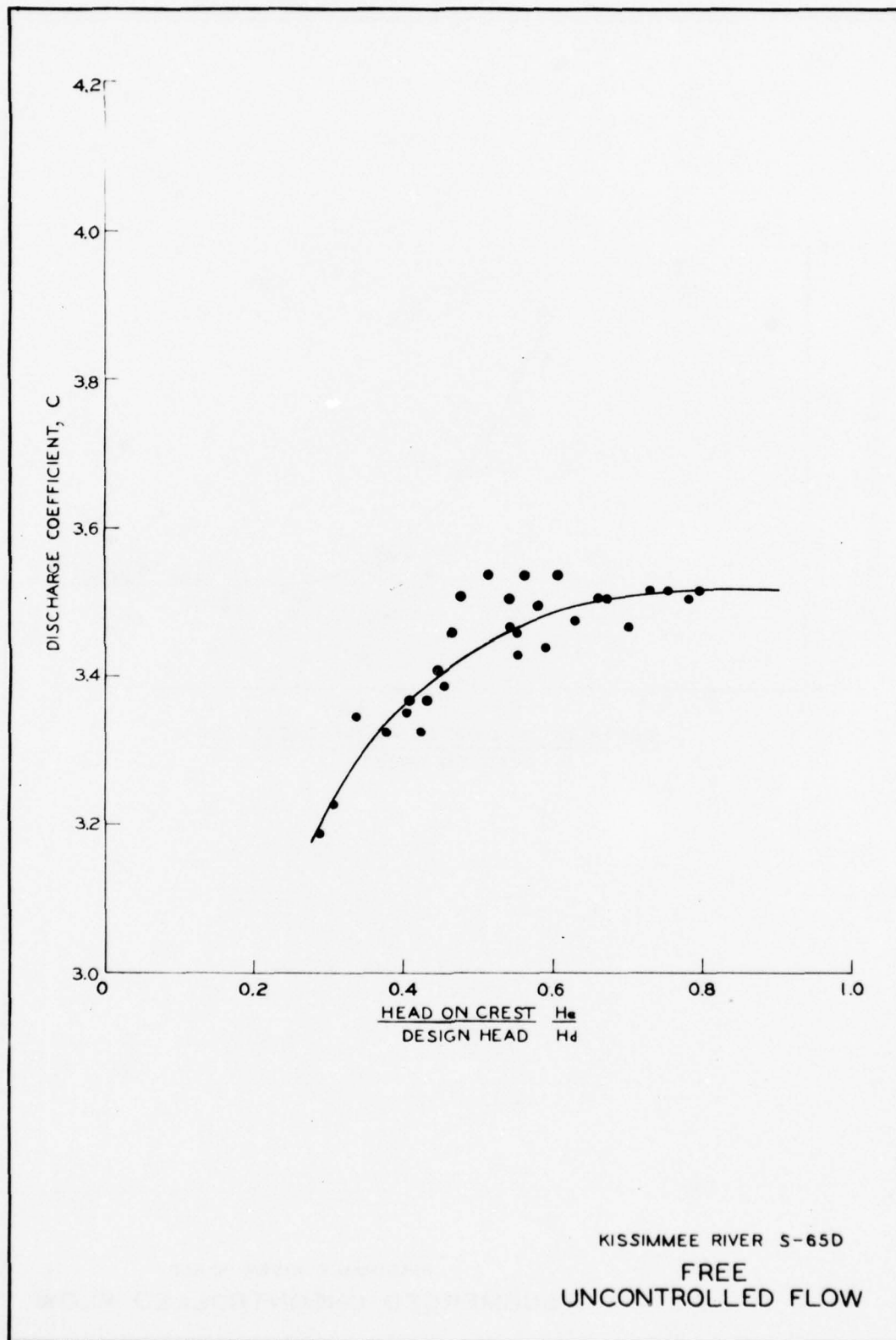
KISSIMMEE RIVER S-65D
CALIBRATION DATA
FOUR- FT GATE OPENING

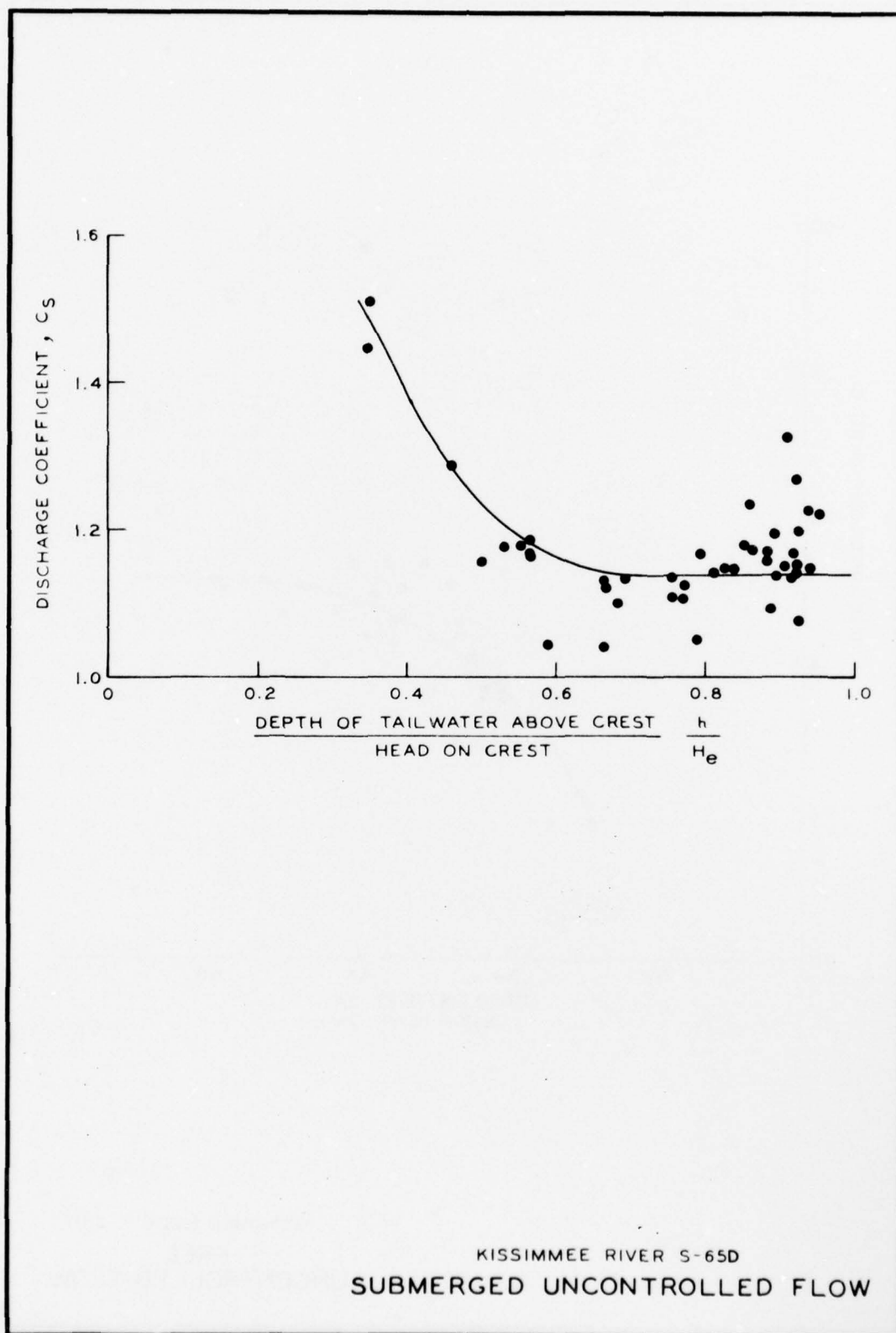


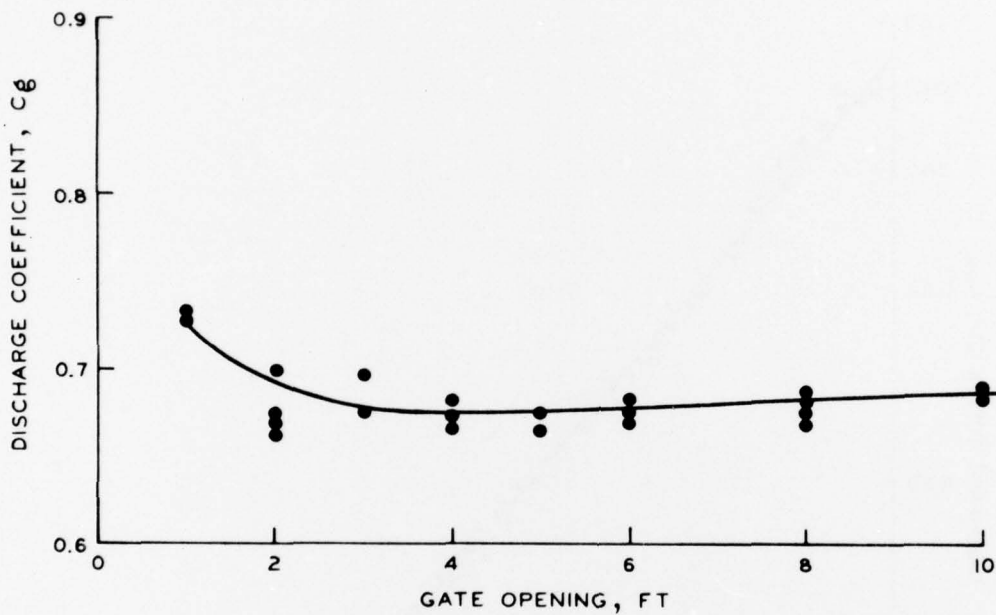
KISSIMMEE RIVER S-65D
CALIBRATION DATA
SIX-FT GATE OPENING



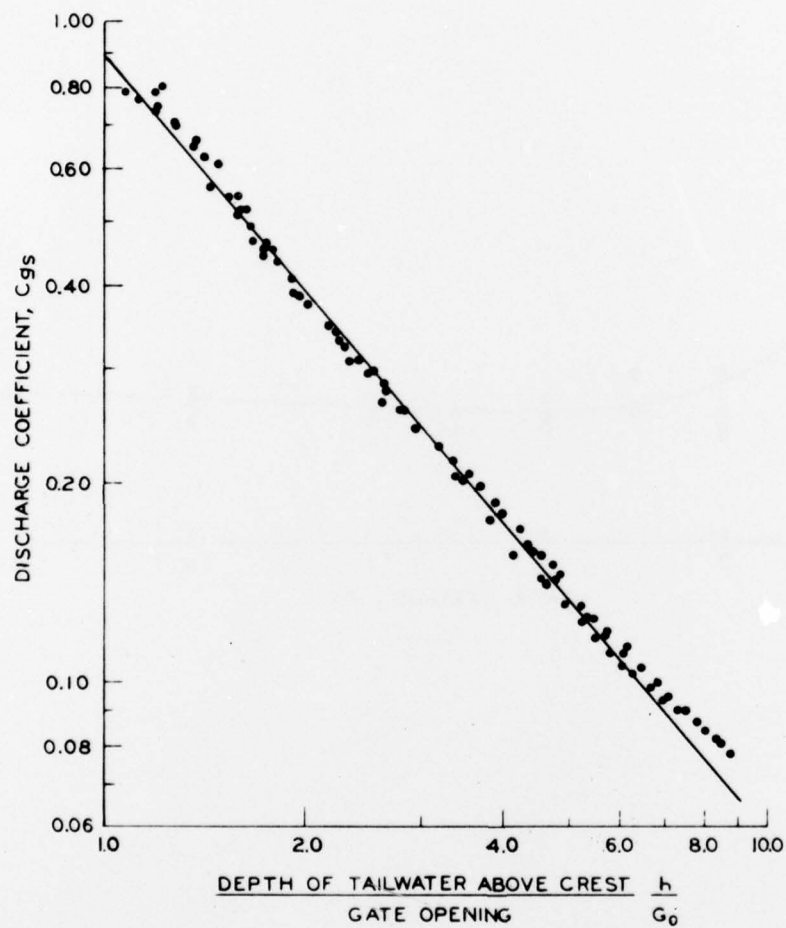
KISSIMMEE RIVER S-85D
CALIBRATION DATA
UNCONTROLLED FLOWS





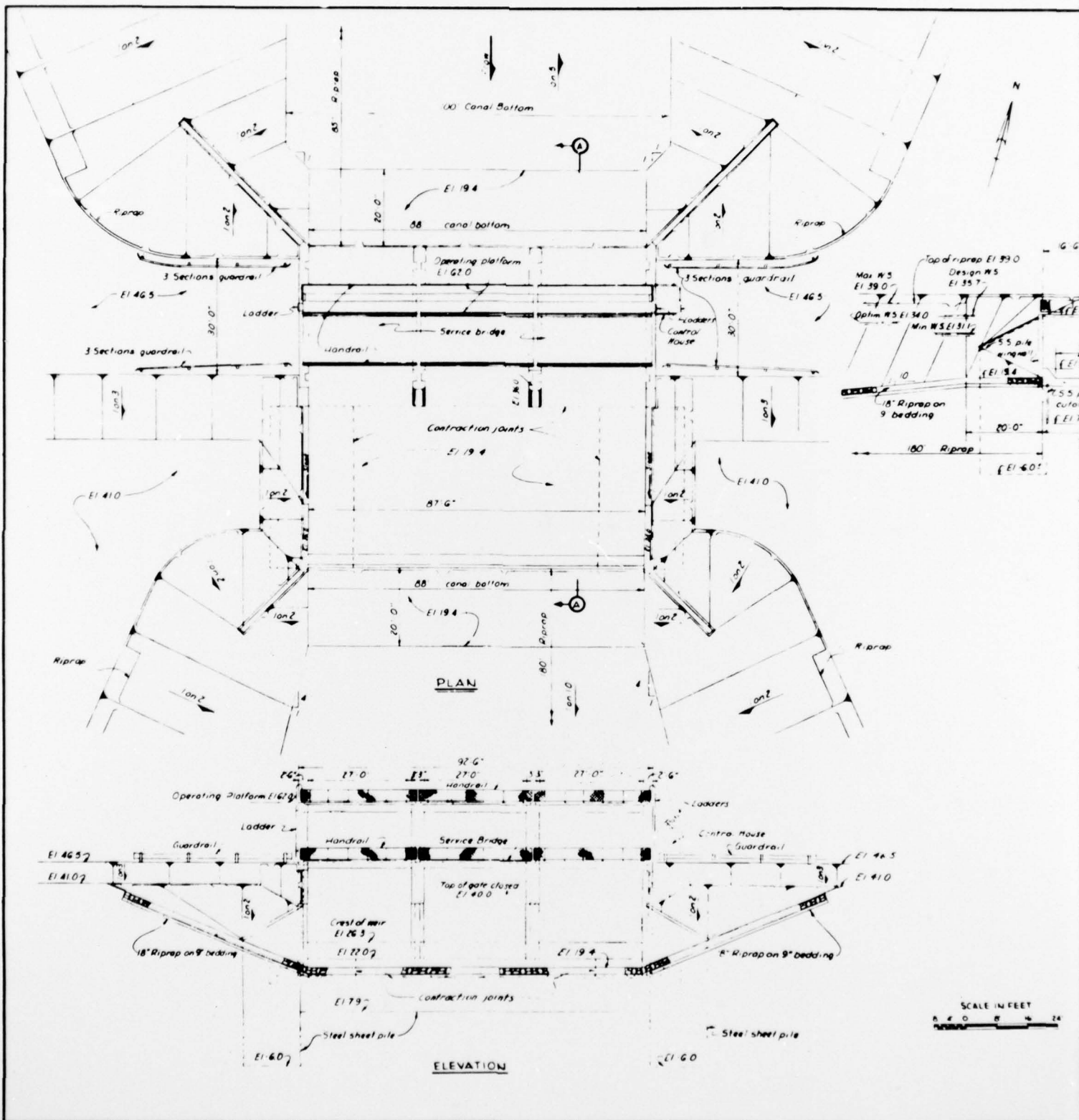


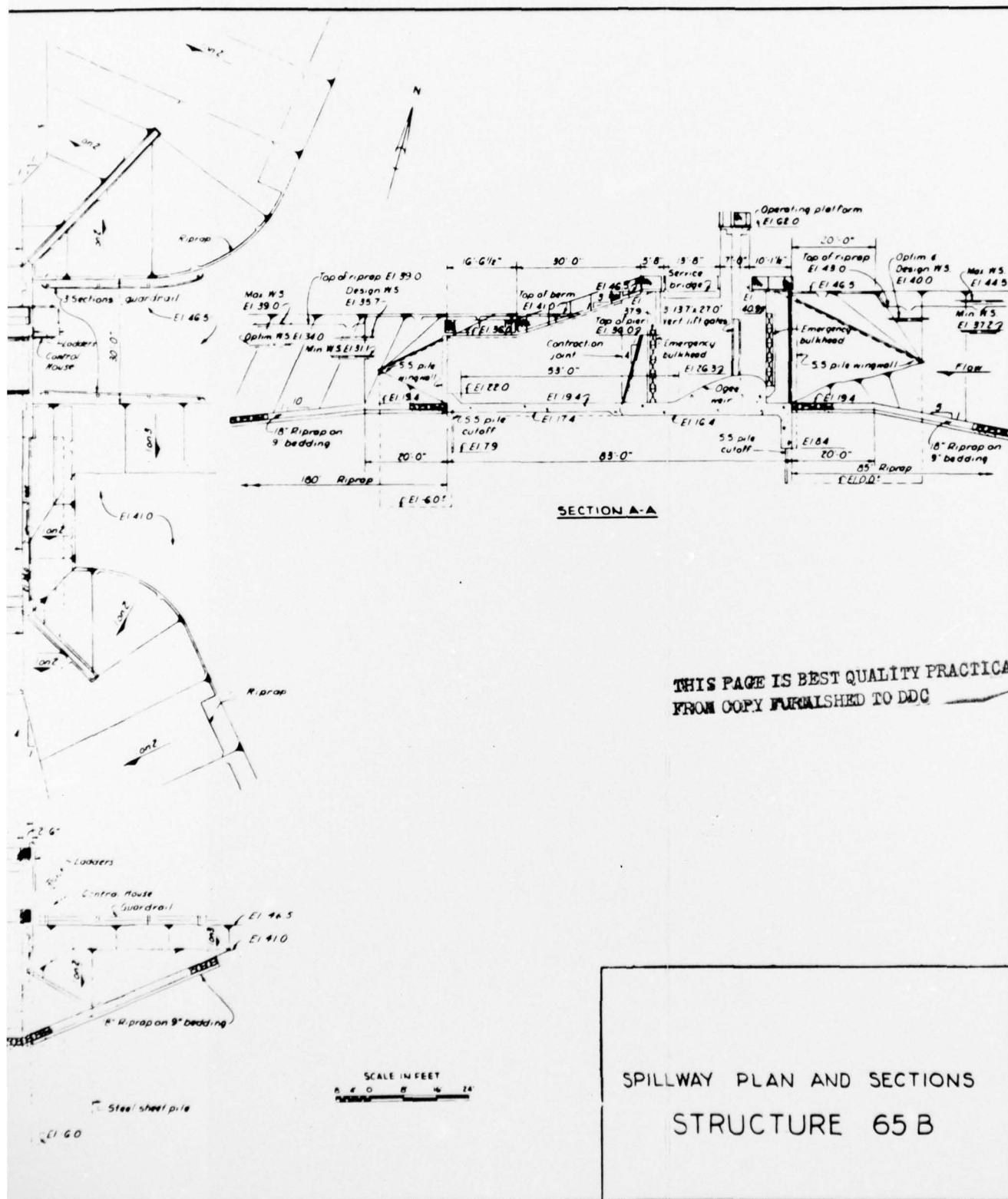
KISSIMMEE RIVER S-65D
FREE CONTROLLED FLOW

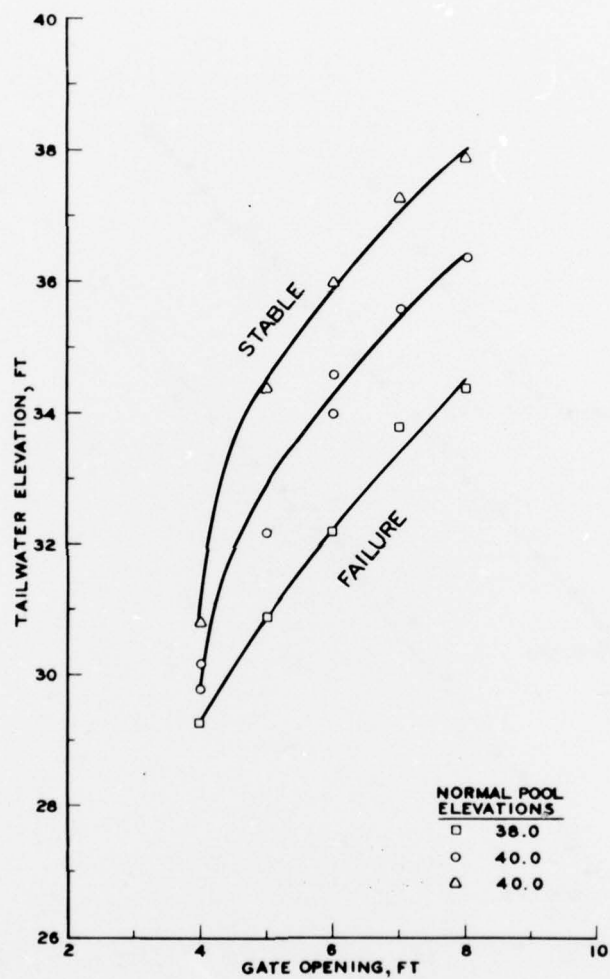


KISSIMMEE RIVER S-65D
SUBMERGED CONTROLLED FLOW

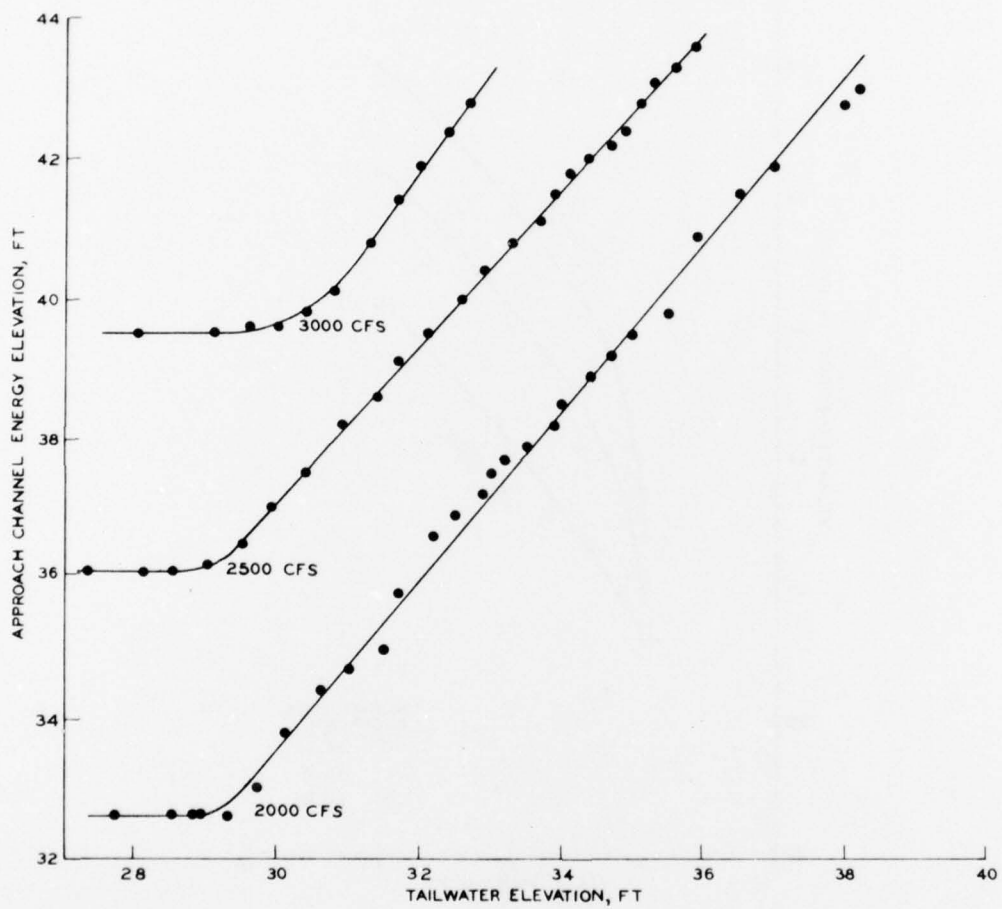
THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC



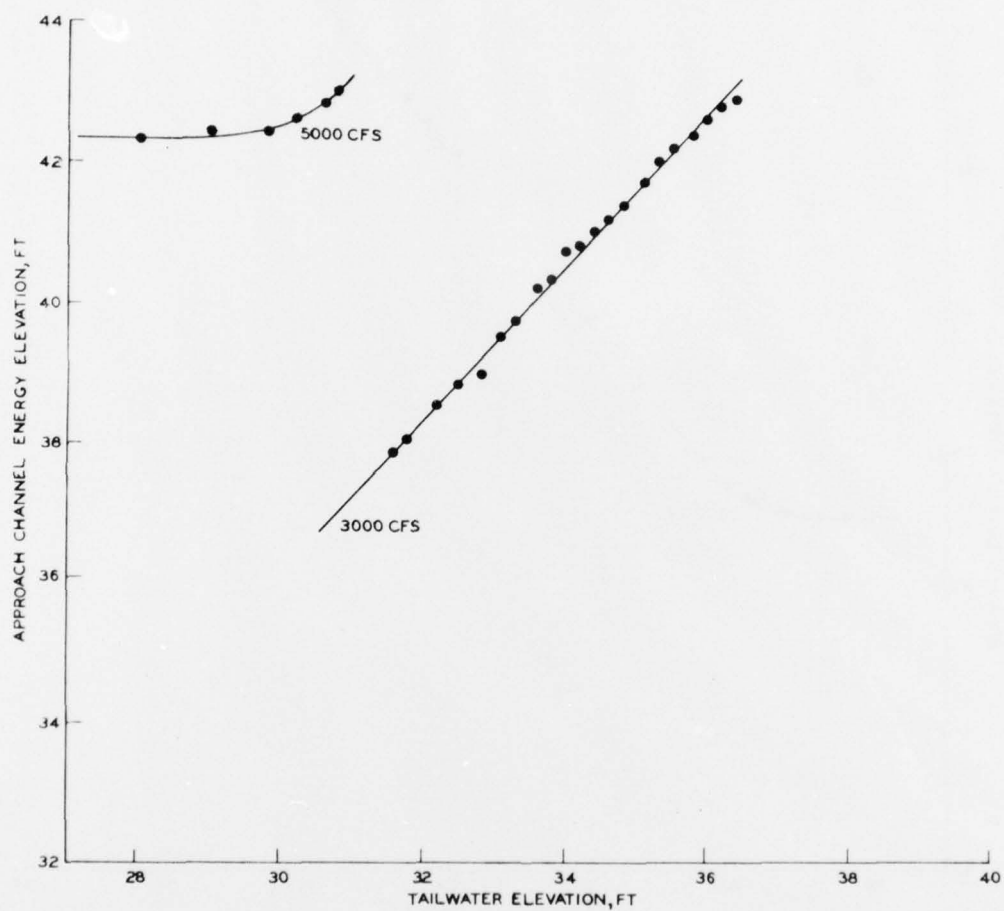




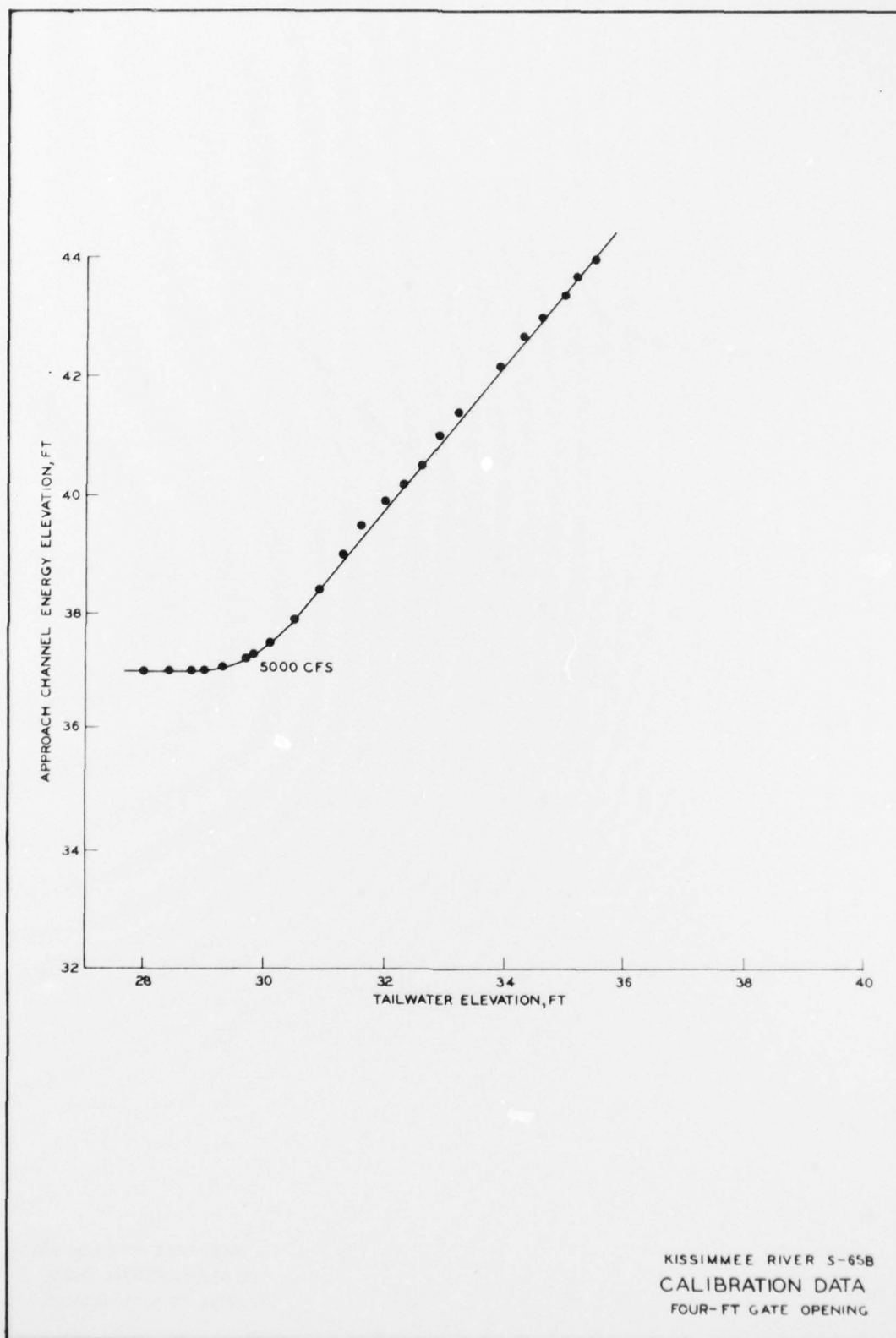
KISSIMMEE RIVER S-65 B
GATE OPENING AND TAILWATER
REQUIRED TO DISPLACE RIPRAP
TYPE I PROTOTYPE

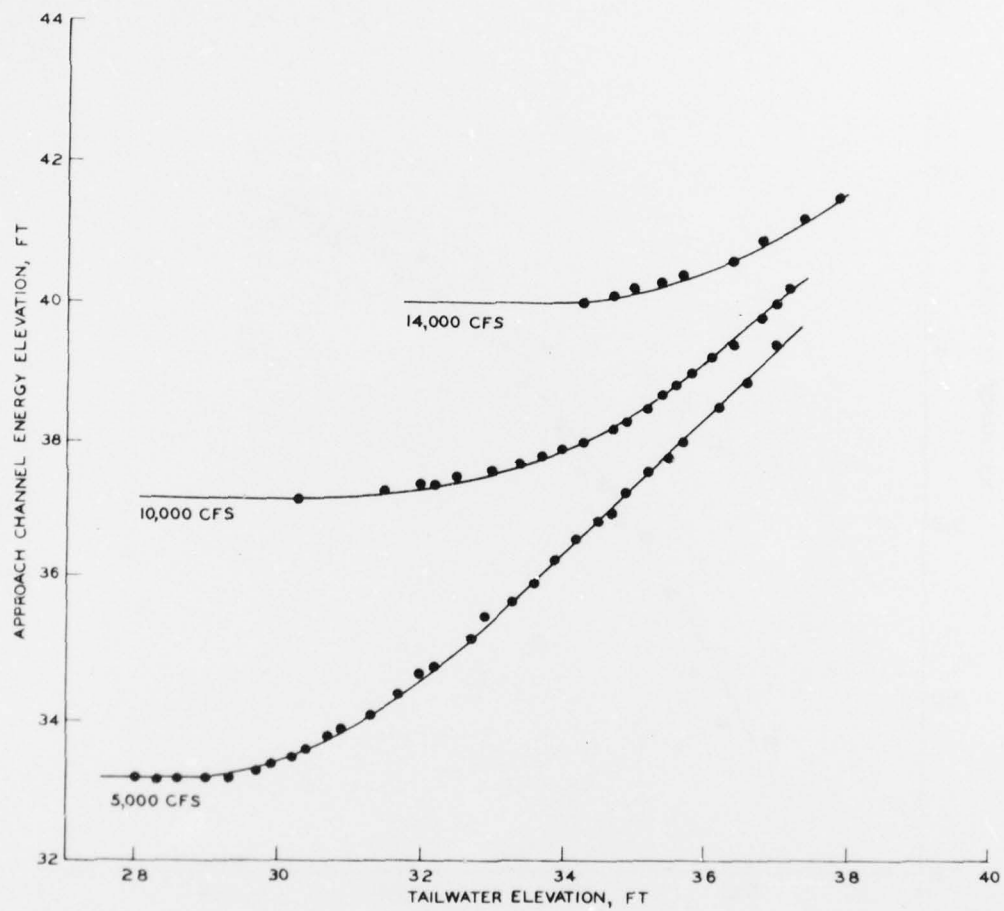


KISSIMMEE RIVER S-65B
CALIBRATION DATA
TWO-FT GATE OPENING

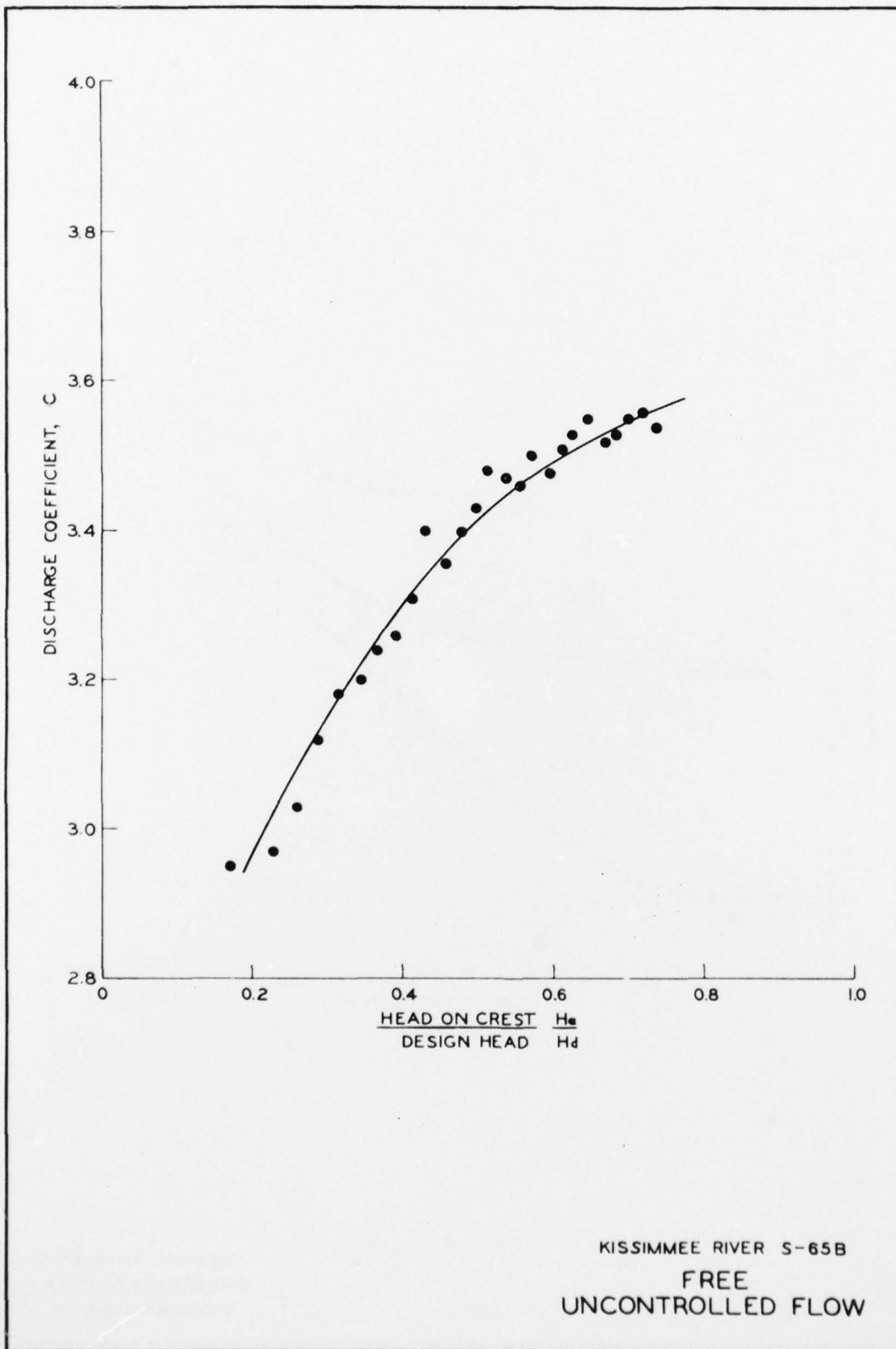


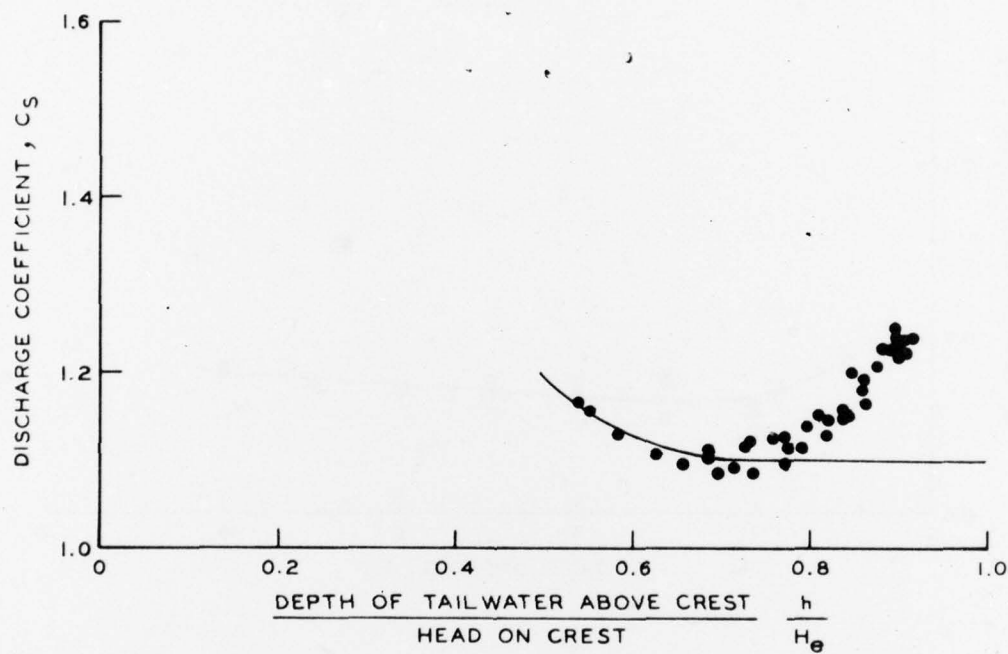
KISSIMMEE RIVER S-65B
CALIBRATION DATA
THREE-FT GATE OPENING



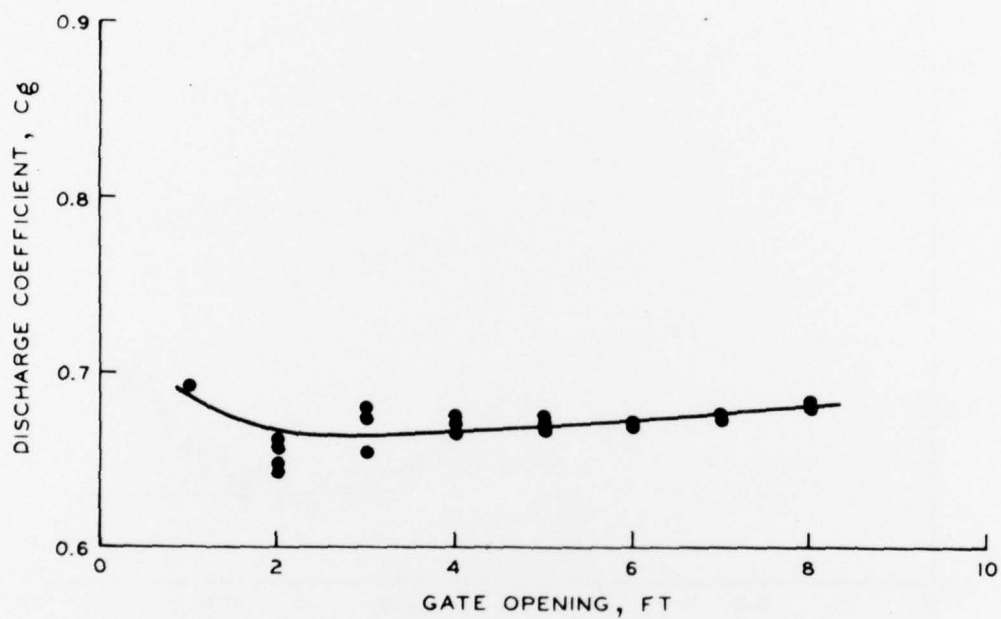


KISSIMMEE RIVER S-65B
CALIBRATION DATA
UNCONTROLLED FLOW

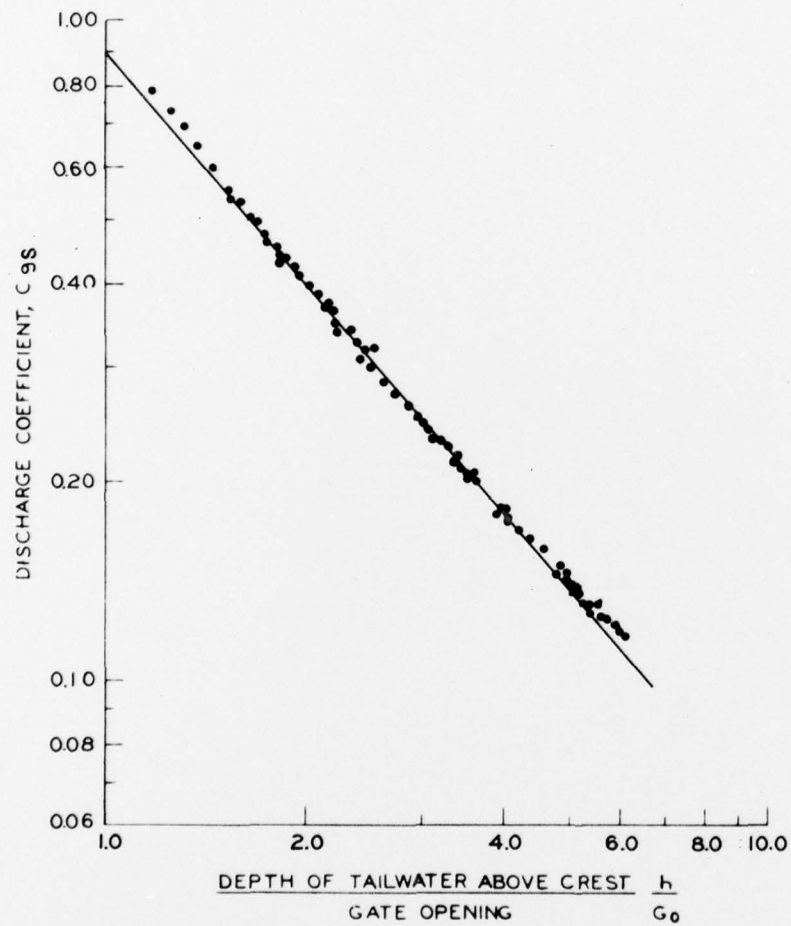




KISSIMMEE RIVER S-65B
SUBMERGED UNCONTROLLED FLOW



KISSIMMEE RIVER S-65B
FREE CONTROLLED FLOW



KISSIMMEE RIVER S-65B
SUBMERGED CONTROLLED FLOW

In accordance with letter from DAEN-RDC, DAEN-AS1 dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Turner, Herman O

Kissimmee River structures, Central and Southern Florida Flood Control Project; hydraulic model investigation / by Herman O. Turner, Jr., Glenn A. Pickering. Vicksburg, Miss. : U. S. Waterways Experiment Station ; Springfield, Va. : available from National Technical Information Service, 1979.

29 p., 37 leaves of plates : ill. ; 27 cm. (Technical report - U. S. Army Engineer Waterways Experiment Station ; HL-79-4)

Prepared for U. S. Army Engineer District, Jacksonville, Jacksonville, Fla., and South Florida Water Management District, West Palm Beach, Fla.

1. Central and Southern Florida Flood Control Project. 2. Control structures. 3. Flood control -- Florida. 4. Hydraulic models. 5. Kissimmee River. I. Pickering, Glenn A., joint author. II. South Florida Water Management District. III. United States. Army. Corps of Engineers. Jacksonville District. IV. Series: United States. Waterways Experiment Station, Vicksburg, Miss. Technical report ; HL-79-4.
TA7.W34 no.HL-79-4